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# RAPLOT II, A COMPUTER PROGRAM FOR DATA PROCESSING AND GRAPHICAL DISPLAY FOR RADIOISOTOPIC SAND TRACER STUDY

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U. S. ARMY, CORPS OF ENGINEERS

COASTAL ENGINEERING
RESEARCH CENTER

Coastal Engineering Research Center
5201 Little Falls Road, N.W.
Washington, D. C. 20016

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## ABSTRACT

RAPLOT II is a computer program for processing radiation and navigation data from field surveys of the Radioisotopic Sand Tracer (RIST) study, but is applicable to any survey type operation on the nearshore Continental Shelf. Collected data are punched onto paper tape by the data collection computer on the research vessel. The data are later transferred to magnetic tape which provides the input for the RAPLOT II Program. Program control parameters are on punched cards. The navigation data, which consists of ranges to two shore-based radar beacons, are first edited for spurious data, and then converted to rectangular coordinates (in this case the California Lambert Coordinate System). Radiation data are converted to count rate as counts per second. Background count rate is computed and subtracted from the observed count rate, and any radiation counts that are significantly above the background count rate are corrected for time of decay since the isotope was injected. Output from the program is in three forms - printed output, graphical output, and magnetic tape record. The processed data are transferred to magnetic tape and made available for further processing such as the generation of contour maps.


## FOREWORD

CERC Miscellaneous Paper 2-69, Radioisotopic Sand Tracer Study, Point Conception, California, reported the early results of the RIST study. This study is part of Contract AT(49-11)-2988 between the Atomic Energy Commission and CERC. Other participants in this continuing multi-agency study are the Oak Ridge National Laboratories of the Atomic Energy Commission; U. S. Navy Pacific Missile Range; U. S. Air Force (Western Test Range, First Strategic Aerospace Division); U. S. Army Corps of Engineers Los Angeles District office; NASA (Nuclear Systems and Space Power Division), the State of California (Department of Water Resources) and U. S. Army Mobility Equipment Command. The study involves the collection and analysis of an enormous amount of data. Computer processing is the only means by which these data could be handled.

Philip A. Turner, a geologist, developed the original RAPLOT program and prepared this report. The work was done under the general supervision of David B. Duane, Chief, Geology Branch, and George M. Watts, Chief, Engineering Development Division. CERC continues to refine data processing and improve the printed and graphic output which consists of maps drawn by an incremental plotter.

At the time of publication, Lieutenant Colonel Edward M. Willis was the Director of CERC; Joseph M. Caldwell was Technical Director.

NOTE: Comments on this publication are invited. Discussion will be published in the next issue of the CERC Bulletin.


This report is published under authority of Public Law 166, 79th Congress, approved July 31, 1945, as supplemented by Public Law 172, 88th Congress, approved November 7, 1963.

CONTENTS

ILLUSTRATIONS

## Section A. INTRODUCTION

In 1966 the Coastal Engineering Research Center (CERC), in cooperation with the Atomic Energy Commission, initiated a 3-year radioisotopic sand tracer study of littoral transport around Point Conception, California. The purpose was to develop and use radioactive tracers for research in sand movement and littoral processes. The objectives included determination of suitable radioactive isotopes, development of handling and survey procedures, and development of computer programs for editing, processing and graphical display of the data. At the same time, studies of sediment transport around the Point Conception headland and of the mechanics of littoral transport were conducted. Methods developed by this program have direct application to engineering design of harbor development and beach erosion prevention, and quasi-military application such as the location of radioactive and other toxic materials.

Sand grains indigenous to the study area are labeled with a radioisotope that does not adversely affect their hydraulic properties. A mobile detector system, using cesium iodide crystals and housed in a "ball" towed behind an amphibious vehicle, detects the location and intensity of the radiation. Concurrently, additional field data are collected on sediment size and composition, isotope distribution, beach and nearshore bottom topography, weather, and sea and swell conditions.

During a sand-tracer field investigation, radiation measurements are made continuously as the mobile detector system is towed along a beach, through the surf, and over the offshore bottom. With a time selection mode for data acquisition available in increments from 0.1 to 10.0 seconds, a large mass of data is accumulated in a few hours. During a field test, surveying may go on several hours a day for several weeks. Computer processing is necessary to study and evaluate the great volume of collected data. Plotting and posting of the survey data is also useful for monitoring field operation.

The initial field investigations at Surf, California, relied on manual preparation of maps and subjective interpretation of data printed by the teletype of the onboard data acquisition system. It immediately became evident that computer processing and plotting must be employed in future operations, and CERC undertook development of computer programs to generate plots useful to continuing field operations. This specific program is called RAPLOT. The first version of the program was used to process the data collected in the December 1967 field test at Point Conception, California, and is documented in Appendix D of CERC report, M.P. 2-69, by Duane and Judge (1969). RAPLOT was originally compiled and made operational on the UNIVAC 1108 at the National Bureau of Standards, with graphic display on a Benson-Lehner incremental plotter at CERC. Later, the program was adapted to the IBM 7094 Computer and Milgo plotter at the Western Test Range of Vandenberg Air Force Base. This version of the program was used to support later field tests at Point Conception and Surf, California, in September and October 1968 and in February and June 1969.

Improvement and modification of program data acquisition systems created changes in the collection format which required a new version of the RAPLOT program. At the same time, experience gained from running the RAPLOT program was incorporated to provide an improved and more sophisticated data processing capability for the RIST project. The new program is called RAPLOT II and was used at CERC for processing field data for all tests after December 1968. Subsequently, the program was modified to run on an IBM 7094 computer to produce plots on a Stromberg-Carlson 4020 cathode ray tube. This version is called RAPLOT III (See Appendix B, page 47).

## Section B. SUMMARY OF RAPLOT II PROGRAM

### 1. Hardware Requirements

RAPLOT II was written in FORTRAN V for the UNIVAC 1108 Computer and EXEC II operating system at the National Bureau of Standards (NBS) in Gaithersburg, Maryland. CERC is connected to NBS by a leased telephone line and has a UNIVAC 1004 for its remote terminal. The NBS UNIVAC 1108 has 65,000 words of core memory of which 38,400 are required for the RAPLOT II Program. FORTRAN V employs advanced features not found in standard FORTRAN IV. They are the NTRAN subroutine for executing binary input-output commands, and the FLD function, a bit manipulation routine.

For field program use, RAPLOT II has been modified and written in FORTRAN IV to run on an IBM 7094 computer at the Pacific Missile Range data processing center at Point Mugu, California. The size of the program had to be reduced considerably to fit into the 32,000 word memory. Consequently, the processing of the data is less thorough, and the writing out of the processed data on magnetic tape was eliminated. This version was used to support a RIST field test near Point Mugu where the primary requirement was for quick printout and graphic display of the processed survey data.

### 2. Program Description and Logic

A flow chart of the program is given in Figure 1; an outline description of the main steps in the program follows:

a. Read in two program control cards and a file legend card. Additional control parameters are computed from these input parameters.

b. Read in from magnetic tape a data file from a radioisotopic tracer survey.

c. Check radar beacon ranges for errors. If distance-time ratio for successive ranges indicates a ship speed greater than 6 knots, or 3.09 meters per second, correct the ranges by linear interpolation. Experience has indicated that these beacon ranges may be erroneous (as much as an order of magnitude) as often as 5 percent of the time.

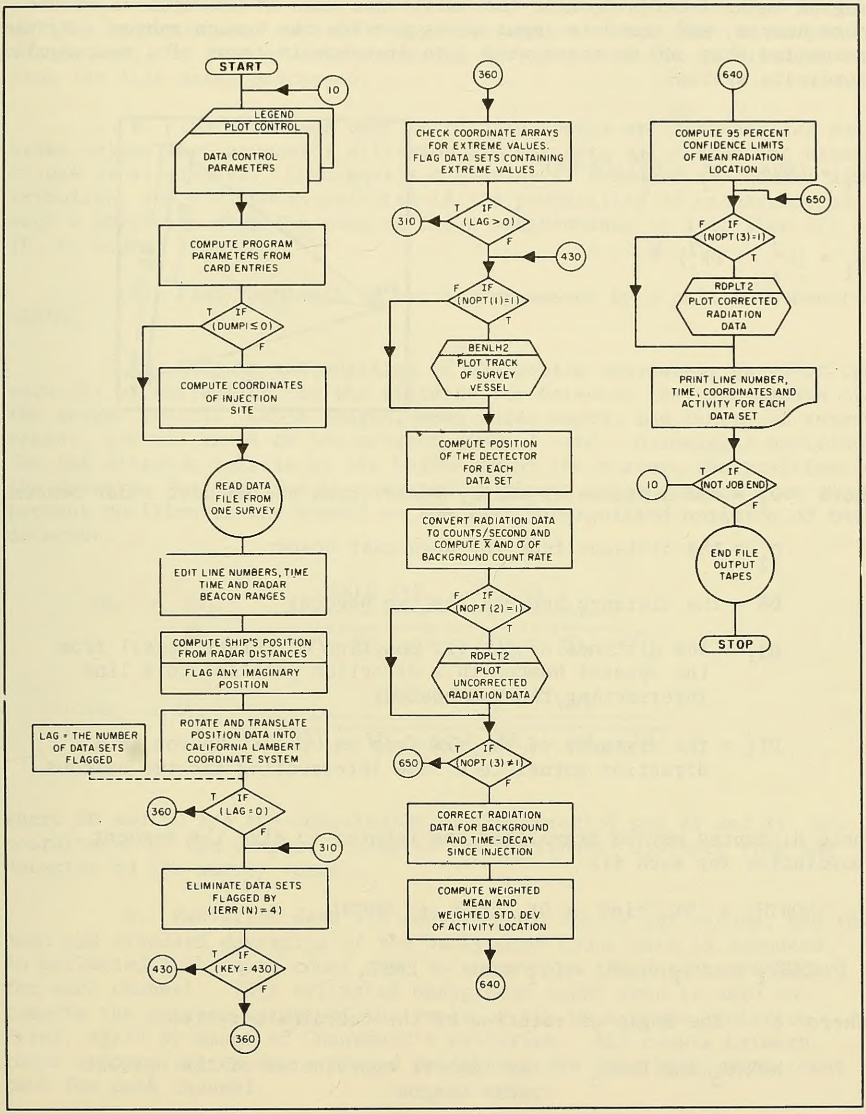
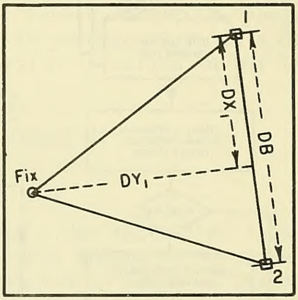



Figure 1. Flow Chart of RAPLOT II Program

d. Compute the position of the survey vessel at each fix. The program control cards provide the California Lambert Coordinates of the shore beacon, and the data input tapes provide the beacon ranges. By the cosine law this can be translated into distance in terms of a rectangular coordinate system:

$$DX_1 = (DB^2 + D_1^2 - D_2^2)/(2 \cdot DB)$$

$$DY_1 = (D_1^2 - DX_1^2)^{1/2}$$




Where $D_1$ = the distance of survey vessel from the upcoast radar beacon

$D_2$ = the distance from the downcoast beacon

DB = the distance between the two beacons

$DX_1$ = the distance of the fix position of survey vessel from the upcoast beacon in a direction parallel to a line intersecting the two beacons

$DY_1$ = the distance of the fix from an upcoast beacon in a direction normal to a line intersecting the two beacons.

These distances may be translated and rotated to give the Lambert Coordinates for each fix

$$NORTH_f = DX_1 \sin\theta + DY_1 \cos\theta + NORTH_b$$

$$EAST_f = DX_1 \cos\theta - DY_1 \sin\theta + EAST_b$$

Where $\theta$ = the angle of rotation of the coordinate system

$NORTH_b$ and $EAST_b$ = the Lambert coordinates of the upcoast radar beacon

$NORTH_f$ and $EAST_f$ = the coordinates of the fix.

Occasionally the two radar beacon ranges will produce an imaginary position. When this occurs, one of the coordinates of the radar fix is defined by the square root of a negative number. When such an imaginary fix occurs, the line of data producing the imaginary fix is eliminated from the file being processed.

e. The north and east coordinate arrays are searched for extreme values by Chauvenet's criterion and any data set containing extreme values is eliminated. Chauvenet's criterion is based on the normal distribution, and a value is rejected if the probability of occurrence of such a deviation from the mean of the n measurements is less than 1/2 n (P. R. Rider, 1933).

f. Plot the track of the survey vessel by a call to subroutine BENLH2.

g. Compute the position of the mobile underwater detector for each fix by correcting for the distance the detector is towed astern of the survey vessel. Cable length, mean water depth, and length of survey vessel, are all input on the program control card. Assuming a position for the detector vehicle at the beginning of the survey, the position of the detector for each fix is computed by linear interpolation from the present position of the vessel to the last interpolated position of the detector.

$$YD_n = YV_n - \frac{CABLE\ (YV_n - YD_{n-1})}{\sqrt{(YV_n - YD_{n-1})^2 + (XV_n - XD_{n-1})^2}}$$

$$XD_n = XV_n - \frac{CABLE\ (YV_n - YD_{n-1})}{\sqrt{(YV_n - YD_{n-1})^2 + (XV_n - XD_{n-1})^2}}$$

where XD and YD are the coordinates of the detector and XV and YV are coordinates of the vessel. CABLE is the horizontal distance from the detector to the survey vessel.

h. Radiation data are converted to counts per second, and the mean and standard deviation of the background count rate is computed. An estimated background count rate is entered on the data control card for each channel. This estimated background count rate is used to compute the extreme values of the range of the background radiation level, again by means of Chauvenet's criterion. All counts between these extreme ranges are averaged to obtain the mean background count rate for each channel.

i. Plot uncorrected radiation values by a call to BENLH2 through RDPLT2 entry.

j. Correct the radiation data by subtracting the mean background count rate. Then correct the remainder, if it is significantly higher than background, for the time of the decay since the isotope was injected.

$$CCR = (NCR - 3\sigma)e^{\Lambda t} + 3\sigma$$

where $$\Lambda = \frac{\log_e(2)}{T_{1/2}} \quad , \quad \text{and}$$

where CCR = the corrected count rate

NCR = the net (observed radiation value less mean background) count rate

$\sigma$ = the standard deviation of the background count rate

$\underline{t}$ = the elapsed time from the injection to the time of the fix

$T_{1/2}$ = the isotope halflife in hours.

Only radiation count rates that are significantly greater than background are corrected for time of decay. Otherwise, in a survey made one or more halflives after the injection, the correction would inflate background radiation readings to such a degree that they would appear to be significant.

k. Compute the weighted mean and weighted standard deviation of the coordinate location of the radioactivity. Compute the 95 percent confidence limits of the mean radiation location.

$$\overline{XD} = \frac{\sum_{i=1}^{n} XD_i \cdot CCR_i}{\sum_{i=1}^{n} CCR_i}$$

- - - - - - - - - - - - - - - - - - - - - - - - -

$$\overline{YD} = \frac{\sum_{i=1}^{n} YD_i \cdot CCR_i}{\sum_{i=1}^{n} CCR_i}$$

l. Print out the sequence number, time, radar beacon ranges, coordinates, and activity for each line of data.

m. Return to the beginning of the program to read in more data control cards, and process another file of data unless it is the end of job, in which case processing ends.

## Section C. SUBROUTINES USED IN THE PROGRAM

### 1. BENLH2 - Plotting Subroutine

Subroutine BENLH2 performs the operations necessary to produce a plot of the trackline and of the radiation data on the Benson-Lehner incremental plotter. BENLH2 does this by calling the several subroutines of the Benson-Lehner plot package which translates the data given to the subroutines by BENLH2 into plot commands that are written out onto magnetic tape. The tape is used to drive a Benson-Lehner model 305 incremental plotter off-line. Figure 2 is a flow chart of this subroutine.

Subroutine TRACK is substituted for subroutine BENLH2 to produce the RAPLOT III program. TRACK interfaces the RAPLOT program with the plot subroutines for the Stromberg-Carlson 4060 cathode ray tube. Otherwise, it functions essentially like subroutine BENLH2. Both subroutines plot the trackline followed by the survey vessel, and both will also plot the uncorrected or corrected radiation values for each survey. These are symbol plots in which the count rate is represented by a symbol indicating a value between arbitrarily fixed limits. For uncorrected radiation, the limits are established in terms of standard deviation from the mean background count rate. For corrected radiation count rate, the internal limits for each symbol are established on a power of 2 scale. Also, a special symbol is used to indicate background if the count rate is less than 3 standard deviations from the background count rate. If the count rate is more than 3 standard deviations below background, the value is not plotted at all. The reason for this is that an abnormally low count rate may indicate that the detector was "flying" meaning that it was not in contact with the ocean bottom at the time of the fix. Both BENLH2 and TRACK will plot the location of the mean radiation position referred to as RADBAR. They may also plot the location of the injection site, if this is desired.

### 2. Statistical Subroutines

The subroutines described below are used to perform certain statistical computations required by the RAPLOT II program. To reduce the time necessary to prepare the program, these subroutines were taken from the STAT-PACK, a library of statistical subroutines available on the UNIVAC 1108 system. Further details may be obtained from the STAT-PACK Programmers' Reference Manual.

Subroutine STDEV computes the standard deviation of an array by the following formula:

$$\sigma = \left( \frac{\sum_{i=1}^{n} (X_i - \overline{X})^2}{n} \right)^{1/2}$$

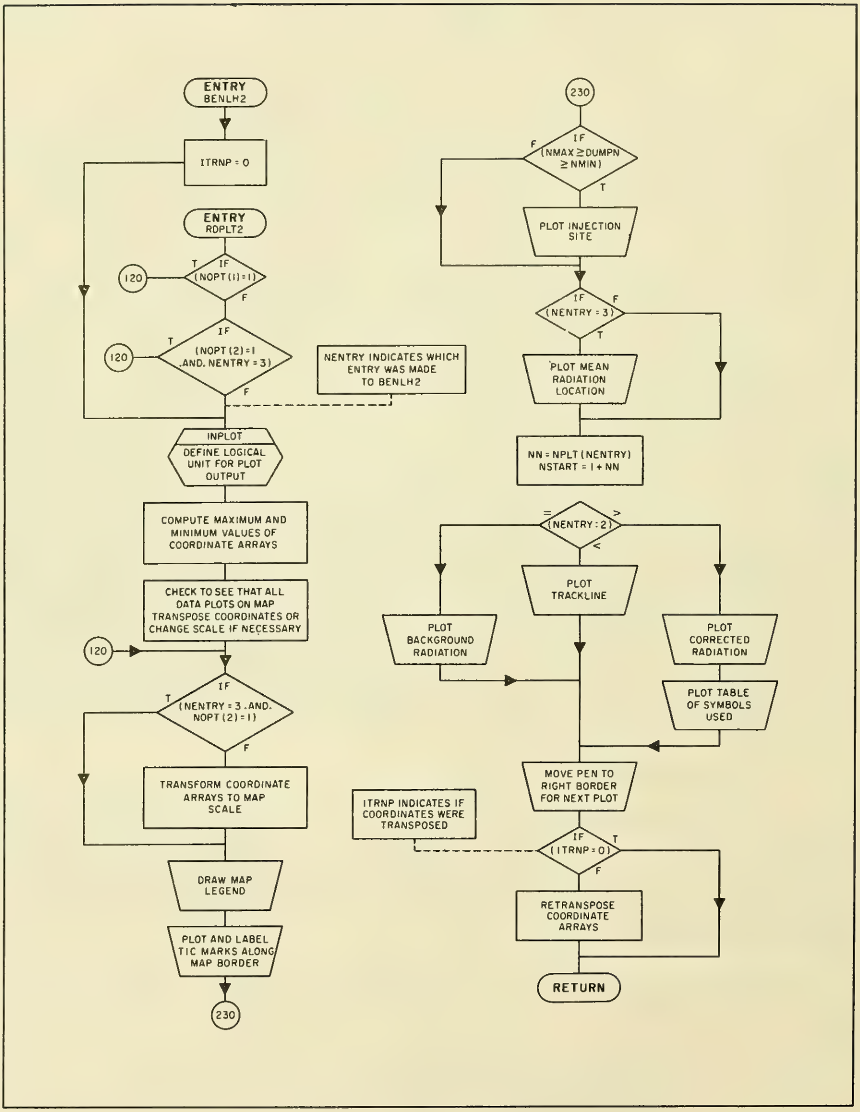



Figure 2. Flow Chart of BENLH2 Program

where $X$ = the array of values

$\overline{X}$ = the arithmetic mean of the X array

$n$ = the number of elements in the X array

$\sigma$ = the standard deviation

Subroutine AMEAN is called to compute the arithmetic mean of the X array.

Subroutine TINORM computes the value of the inverse of the normal distribution by a rational approximation. The inverse normal distribution is defined by the solution for X of the following integral equation

$$\frac{1}{\sqrt{2\pi}} \int_{-\infty}^{X} e^{-t^2/2} \, dt = \alpha$$

where $\alpha$ is the probability for which the ordinate is to be calculated. The rational approximation itself may be ascertained from the FORTRAN statements in the subroutine.

3. Input-Output Subroutines

The binary input-output statements in FORTRAN, although convenient to use, cannot make efficient use of magnetic tapes because the language does not permit total parallel processing. Furthermore, a considerable amount of time is used in processing a list because of its generality. More efficient use is attained by buffering the input or output in parallel with computing. On the UNIVAC 1108 system the NTRAN subroutine provides a means of buffering through a call statement in FORTRAN:

```
CALL NTRAN (UNIT, sequence of operations)
```

in which UNIT is an integer constant or variable designating the logical unit. If the unit is not busy, NTRAN initiates the first operation and stacks the remainder in a waiting list. If the unit is already busy, then the entire sequence is stacked in a waiting list and chained to the previously stacked sequence. Control is then returned to the program following the call NTRAN statement. When an interrupt occurs, NTRAN records the transmission status, initiates the next operation in the chain and returns control to the interrupted program.

The NTRAN subroutine is used to write out on magnetic tape the arrays containing the legend, sequence number, underwater detector coordinates and corrected count rate for both radiation channels for each file of survey data being processed. The information thus stored on

magnetic tape may be used for further processing such as drawing contour maps. No provision is made for outputting the processed data in RAPLOT III because no further processing was planned for any of the field test sites. Also deletion of the output statements reduces the running time of the program.

Call NTRAN statements are also used in RAPLOT II to position the input tape by end of file marks.

## Section D. PROGRAM INPUT

### 1. Card Input

Input for the RAPLOT II program comes from punched cards and from magnetic tape. Three program control cards are read in for each file of survey data processed. Formats, and descriptions of the variables written onto the cards are given in Table I; names given to the variables in this table are the ones employed by the program. Figure 3 shows a data sheet that is used for filling out the control cards. It is useful not only for filling in the parameters on the cards, but also for keeping track of the data files when large numbers of files are being processed.

The last 12 characters of the legend (Card 3, spaces 66-78) are used for file identification. Before a file of survey data is read in, a 7-word identification array called SENTNL is read in from the beginning of the tape file. The first two words in SENTNL are compared with the last two words in LEGEND. If a match is not found, the tape is positioned at the beginning of the next file and a new SENTNL array is read in. This procedure is in lines 48 through 52 of the source language listing of RAPLOT II in Appendix A. It has been deleted from RAPLOT III.

### 2. Tape Input

When a RIST survey is underway in the field, data from various sensors are assembled by the onboard detector system, and punched on 8-channel paper tape in American Standard Code for Information Interchange (ASCII) code. At present, there are seven data fields for each line of record. A brief description of the variables and the tape record format is given in Table II; Figure 4 is a sample listing from a paper-tape data file.

In the actual processing of the RIST data files, it has been found necessary to edit the data files prior to putting them through the RAPLOT II program. The edited data are written out in unformatted magnetic tape files. This is why the READ statement in line 58 of the listing in Appendix A is an unformatted FORTRAN READ statement. Unformatted (or binary) input-output statements are much more efficient for the computer to execute than formatted statements. For that reason, they are employed wherever possible. RAPLOT III employs a formatted READ statement (line 51, Appendix B) for inputting a data file, since the need for short turn-around time is greater than the need to edit data files when supporting a field test.

TABLE I

Format of Program Control Cards

I Data Control Card (3F3.0,2F7.0,1X,2F2.0,F3.0,F5.2,3F2.0,4(1X,F7.0),I3)

| Column | Variable | Description |
|---|---|---|
| 1-3 | CABLE | Length of cable, in feet, on which the detector is towed. |
| 4-6 | DEPTH | Average water depth plus freeboard, in feet. |
| 7-9 | BOAT | Distance from radar mast to cable stanchion in feet. |
| 10-16 | BKG(1) | Estimated background count rate (counts per second) for radiation channel 1. |
| 17-23 | BKG(2) | Same for radiation channel 2. |
| 25-28 | ZHR,ZMIN | The time of injection in hours and minutes (24-hour clock). |
| 29-31 | DAYS | The number of days that have elapsed since the injection. |
| 32-36 | HLIFE | The halflife of the radioisotope in days. |
| 37-40 | SETIME, RMIN | The time when the survey was started, in hours and minutes (24-hour clock). |
| 41-42 | SEC | The time, in seconds, between successive fixes. |
| 44-50<br>52-58<br>60-66<br>68-74 | BEAC1N<br>BEAC1E<br>BEAC2N<br>BEAC2E | California Lambert Coordinates of the radar beacons. BEACON 1 is always the upcoast beacon. |
| 75-77 | ISKIP | The number of lines to skip at the beginning of a data set in order to avoid reading in some bad data. |

TABLE I (Continued)

Format of Program Control Cards

II Plot Control Card (4I1,F10.0,1X,3I2,1X,F10.0,2(1X,F10.0),1X,A6)

| Column | Variable | Description |
|---|---|---|
| 1-4 | NOPT | Plot option controls. A numeral 1 in the column indicated causes the various options to be executed. |
| 1 | | Plot trackline followed by survey vessel. |
| 2 | | Plot uncorrected radiation values. |
| 3 | | Plot radiation values corrected for background and for decay since injection. |
| 4 | | Unused. |
| 5-14 | SCALE | Map scale in feet per inch. |
| 16-17<br>18-19<br>20-21 | NPLT(1)<br>NPLT(2)<br>NPLT(3) | Options used for spotting data points for each plot option. User can specify that every Nth point be plotted. If left blank, every point will be plotted. |
| 23-32 | GRID | Intervals on the coordinate grid at which Lambert Coordinates will be posted. If GRID=0, tick marks are not plotted. |
| 34-43<br>45-54 | DUMP 1<br>DUMP 2 | Distance in meters from the injection site to the upcoast and downcoast beacon, respectively. If the fields are blank, then the injection site is not plotted. |
| 56-61 | INDATE | Day, month and year that the radioactive sand was injected. |

III Plot legend card (13A6,L2)

| Column | Variable | Description |
|---|---|---|
| 1-78 | LEGEND | A descriptive legend that is included on the printed output, and is also written on the lower margin of the map. |
| 79-80 | JOBEND | The letter 'T' is entered here if the data file being processed is the last one in the job. Otherwise the field is left blank. |

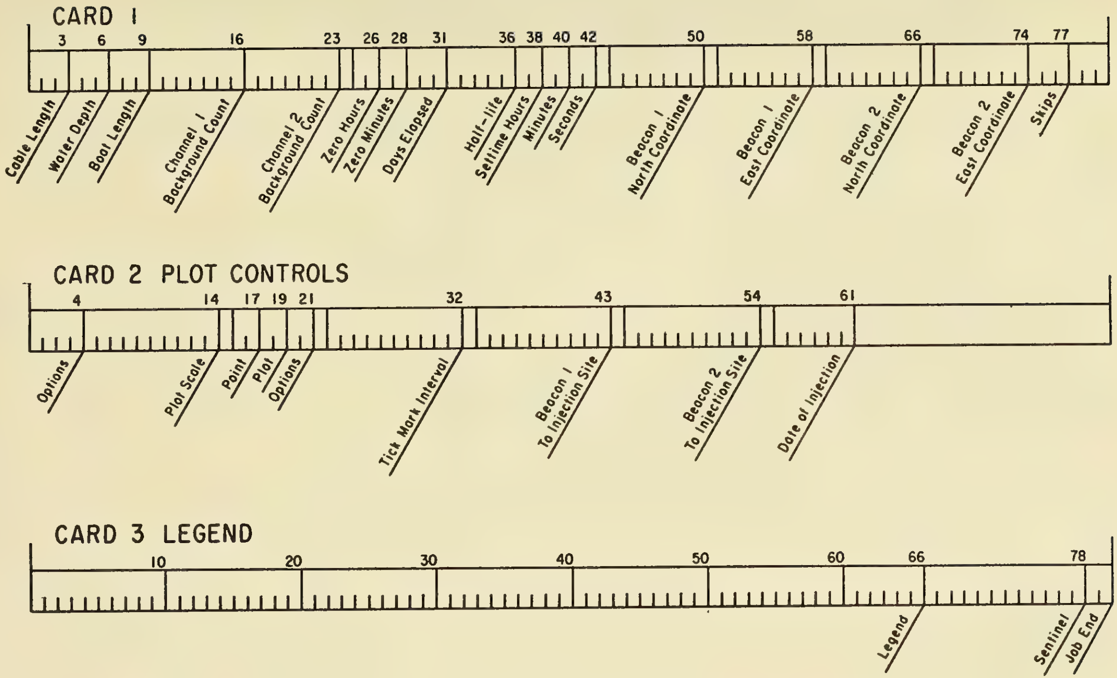



Figure 3. Data Sheet for RAPLOT II Control Cards

TABLE II

Format of Paper-tape Record on Which RIST Survey Data is Collected
Paper-Tape Format (I6,3F7.1,3F7.0)

| Column | Array | Description |
|---|---|---|
| 1-6 | NMBR | A line (record) number which is incremented with each line of data unless manually reset. |
| 8-13 | TIME | Cumulative time, in tenths of seconds, since the beginning of the survey. Time is reset to zero at the beginning of each survey. |
| 15-20 | $D_1$ | Distance, in tenths of meters, from the upcoast radar responder beacon. |
| 22-27 | $D_2$ | Distance, in tenths of meters, from the downcoast radar responder beacon. |
| 29-34 | $RAD_1$ | Radiation Channel 1: pulses from differential discriminator accumulated for time between successive records. It is automatically reset to zero at the writing of each record. |
| 36-41 | $RAD_2$ | Radiation Channel 2: same description. |
| 43-48 | FATH | Depth of water recorded by fathometer. This is not presently in operation. |

| | | | | | | |
|---|---|---|---|---|---|---|
| 000061 | 001240 | 001763 | 004900 | 000236 | 000201 | 000000 |
| 000062 | 001260 | 001793 | 004916 | 000175 | 000142 | 000000 |
| 000063 | 001280 | 001814 | 004919 | 000155 | 000132 | 000000 |
| 000064 | 001300 | 001846 | 004924 | 000150 | 000130 | 000000 |
| 000065 | 001320 | 001861 | 004929 | 000142 | 000119 | 000000 |
| 000066 | 001340 | 001878 | 004930 | 000152 | 000136 | 000000 |
| 000067 | 001360 | 001920 | 004920 | 000149 | 000124 | 000000 |
| 000068 | 001380 | 001925 | 004825 | 000152 | 000116 | 000000 |
| 000069 | 001400 | 001958 | 004947 | 000136 | 000114 | 000000 |
| 000070 | 001420 | 001980 | 004975 | 000130 | 000110 | 000000 |
| 000071 | 001440 | 001022 | 004932 | 000130 | 000101 | 000000 |
| 000072 | 001460 | 002027 | 004932 | 000127 | 000104 | 000000 |
| 000073 | 001480 | 002043 | 004945 | 000144 | 000117 | 000000 |
| 000074 | 001500 | 002092 | 004977 | 000145 | 000123 | 000000 |
| 000075 | 001520 | 002120 | 004966 | 000108 | 000089 | 000000 |
| 000076 | 001540 | 002143 | 004970 | 000140 | 000115 | 000000 |
| 000077 | 001560 | 002157 | 004970 | 000143 | 000117 | 000000 |
| 000078 | 001580 | 002189 | 004979 | 000174 | 000136 | 000000 |
| 000079 | 001600 | 002206 | 004981 | 000142 | 000114 | 000000 |
| 000080 | 001620 | 002234 | 004999 | 000138 | 000122 | 000000 |
| 000081 | 001640 | 002265 | 004996 | 000133 | 000108 | 000000 |
| 000082 | 001660 | 002286 | 004998 | 000188 | 000155 | 000000 |
| 000083 | 001680 | 002315 | 004016 | 000122 | 000101 | 000000 |
| 000084 | 001700 | 002327 | 005048 | 000164 | 000131 | 000000 |
| 000085 | 001720 | 002365 | 005011 | 000166 | 000133 | 000000 |
| 000086 | 001740 | 002386 | 005021 | 000178 | 000151 | 000000 |
| 000087 | 001760 | 002403 | 005039 | 000152 | 000120 | 000000 |
| 000088 | 001780 | 002448 | 005075 | 000133 | 000105 | 000000 |
| 000089 | 001800 | 002471 | 005073 | 000154 | 000131 | 000000 |
| 000090 | 001820 | 002497 | 005077 | 000169 | 000143 | 000000 |
| 000091 | 001840 | 002509 | 005089 | 000151 | 000128 | 000000 |
| 000092 | 001860 | 002549 | 005109 | 000174 | 000153 | 000000 |
| 000093 | 001880 | 002580 | 005135 | 000153 | 000130 | 000000 |
| 000094 | 001900 | 002611 | 005138 | 000158 | 000126 | 000000 |
| 000095 | 001920 | 002629 | 005156 | 000154 | 000124 | 000000 |
| 000096 | 001940 | 002658 | 005164 | 000145 | 000114 | 000000 |
| 000097 | 001960 | 002693 | 005191 | 000170 | 000141 | 000000 |
| 000098 | 001980 | 002719 | 005207 | 000189 | 000151 | 000000 |
| 000099 | 002000 | 002757 | 005211 | 000167 | 000137 | 000000 |
| 000100 | 002020 | 000774 | 005219 | 000147 | 000120 | 000000 |
| 000101 | 002040 | 000808 | 005238 | 000170 | 000133 | 000000 |
| 000102 | 002060 | 002836 | 005266 | 000173 | 000129 | 000000 |
| 000103 | 002080 | 002868 | 005272 | 000149 | 000126 | 000000 |
| 000104 | 002100 | 002902 | 005280 | 000146 | 000126 | 000000 |
| 000105 | 002120 | 002916 | 005302 | 000192 | 999149 | 000000 |
| 000106 | 002140 | 002958 | 005322 | 000140 | 000114 | 000000 |
| 000107 | 002160 | 002997 | 005342 | 000170 | 000136 | 000000 |
| 000108 | 002180 | 002028 | 005355 | 000163 | 000133 | 000000 |
| 000109 | 002200 | 003044 | 005363 | 000142 | 000121 | 000000 |

Figure 4. Sample Listing of Input Data File for RAPLOT II

## Section E. PROGRAM OUTPUT

### 1. Printed Output

Three forms of output are generated by the RAPLOT II program - printed output, graphical output, and magnetic tape output.

The printed output for one data file consists of one page listing the program control parameters and summary statistics (Figure 5) followed by a complete listing of the unprocessed and processed data arrays (Figure 6).

The printout of program parameters and summary statistics for RAPLOT III (Figure 7) is virtually the same. However, the radar-range data and uncorrected radiation data are deleted from the printed listing (Figure 8). Also, only one channel of corrected radiation data is included.

Because of the large volume of data files that may be processed by the RAPLOT II program, it is usually necessary to keep track of the number of pages of output. Fifty lines are printed to a page of output; one page is required for program control parameters and another page for summary statistics. Therefore, the number of pages per data file = 2 + (number of lines of data/50.)

### 2. Graphical Output

Graphical output from RAPLOT II is in the form of plot commands that are either written out on magnetic tape or punched onto cards to be used to drive a Benson-Lehner plotter off-line. Under the present setup, the plot commands are written out on logical tape unit 9; therefore, this same unit cannot be used for other tape input or output without first making changes. On the UNIVAC 1108 system, the plot commands are blocked and written out in card image length records at 556 bits per inch in even parity, BCD. Experience has shown that one full tape will hold approximately 20 separate plots. Assuming that 2 plots are generated per file of data, this means that 10 files of radiation survey data will generate a full tape of plot commands.

RAPLOT II graphical output consists of three types of plots - plots of the trackline followed by the survey vehicle, plots of uncorrected radiation data (for plotting background radiation), and plots of corrected radiation data. Selection of the various plots is controlled by the variable NOPT in Table I. The plot selection options are independent of each other. Any one of the three plot types may be selected, or all three if it is desired. Normally, the trackline plot is selected and then, depending on whether the data is from a background or a radiation survey, either the plot of uncorrected radiation or corrected radiation data is selected. Plots of the survey vehicle trackline and the corrected radiation data are shown in Figures 9 and 10.

```
REAL TIME CLOCK INTERROGATED AT 17:3?.15
          SURF  600 FT S  R-158 O/S  RADIATION SURVEY  AU-198        1451  10/04/1968 5          F

     BEACON 1   451655.N  1217236.E     BEACON 2   445357.N  1218250.E


     SQUARE DIST BETWEEN =     .40693000+08     DISTANCE BETWEEN =     6379.
     SINE =   -.98728560-00     COSINE =    .15895643-00
     INJECTION TIME =11.13.            CLOCK SET AT14.51.     DIGITIZING INTERVAL = 2.SECONDS
     DAYS ELAPSED SINCE INJECTION = 0.
     HALF-LIFE OF ISOTOPE =   3.00DAYS     DECAY FACTOR =    .96270442-02     TIME-DELAY FACTOR =   3.63HOURS
          CABLE LENGTH = 75.           MEAN WATER DEPTH = 10.          BOAT LENGTH = 12.
          DISTANCE FROM RADAR MAST TO DETECTOR =  86.3FEET.


                                   PLOTS GENERATED
          TRACKLINE    1          BACKGROUND RADIATION    0          CORRECTED RADIATION    1

                    10/04/1968 5


                    SUMMARY STATISTICS OF BACKGROUND RADIATION COUNT RATE
                              RAD CHANNEL 1      RAD CHANNEL 2
          EST. BKG. COUNTS/SEC.      310.               250.
          MEAN BKG. COUNTS/SEC.      317.               254.
          STD. DEV. COUNTS/SEC.       20.                18.


                    SUM OF CORRECTED RADIATION COUNTS
                         RADIATION CHANNEL 1     .40784094+07
                         RADIATION CHANNEL 2     .24124798+07


                    SUMMARY STATISTICS OF RADIATION LOCATION.
                        NORTH COORD          EAST COORD
                MEAN        445611.            1217433.
            STD. DEV.           47.                 89.
           CONFIDENCE
        LIMIT OF MEAN            1.                  2.


        MAXIMUM COORD       446198.N           1218147.E


        MINIMUM COORD       444978.N           1216821.E
```

Figure 5. Printed Output of RAPLOT II Program Control Parameters and Summary Statistics for One Data File

SURF 600 FT S R-158 O/S RADIATION SURVEY AU-198 1451 10/04/1968 5

| LINE | TIME SEC | DISTANCE TO BEACON 1 | 2 | RADIATION COUNT RAD1 | RAD2 | BOAT COORDINATES N | E | BALL COORDINATES N | E | CORRECTED RADIATION RAD1 | RAD2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 54 | 110. | 1843.1 | 239.7 | 8065. | 6066. | 445604. | 1217494. | 445587. | 1217578. | 3848. | 2879. |
| 55 | 112. | 1842.5 | 241.9 | 1860. | 1502. | 445606. | 1217487. | 445588. | 1217571. | 635. | 515. |
| 56 | 114. | 1841.9 | 243.1 | 8107. | 6305. | 445608. | 1217483. | 445589. | 1217567. | 3870. | 3003. |
| 57 | 116. | 1840.9 | 245.2 | 958. | 762. | 445611. | 1217477. | 445591. | 1217561. | 167. | 132. |
| 58 | 118. | 1840.3 | 247.1 | 2725. | 2215. | 445612. | 1217471. | 445592. | 1217555. | 1083. | 884. |
| 59 | 120. | 1840.7 | 248.6 | 17401. | 12640. | 445611. | 1217465. | 445593. | 1217549. | 8684. | 6284. |
| 60 | 122. | 1839.4 | 251.8 | 10481. | 8538. | 445615. | 1217455. | 445595. | 1217540. | 5100. | 4159. |
| 61 | 124. | 1838.8 | 254.7 | 60955. | 45884. | 445616. | 1217446. | 445598. | 1217530. | 31244. | 23503. |
| 62 | 126. | 1839.2 | 255.7 | 45464. | 34421. | 445615. | 1217442. | 445598. | 1217527. | 23220. | 17566. |
| 63 | 128. | 1837.9 | 257.9 | 94671. | 51929. | 445619. | 1217436. | 445600. | 1217520. | 48708. | 26635. |
| 64 | 130. | 1837.1 | 260.6 | 77135. | 35455. | 445621. | 1217427. | 445602. | 1217511. | 39625. | 18102. |
| 65 | 132. | 1836.5 | 262.7 | 99527. | 52681. | 445623. | 1217421. | 445603. | 1217505. | 51224. | 27025. |
| 66 | 134. | 1837.2 | 264.2 | 93090. | 48696. | 445621. | 1217415. | 445604. | 1217499. | 47890. | 24961. |
| 67 | 136. | 1835.1 | 266.0 | 97057. | 46751. | 445627. | 1217411. | 445606. | 1217494. | 49945. | 23953. |
| 68 | 138. | 1836.4 | 267.7 | 90077. | 55047. | 445623. | 1217403. | 445607. | 1217488. | 46330. | 28251. |
| 69 | 140. | 1835.1 | 270.0 | 102924. | 54563. | 445627. | 1217397. | 445608. | 1217481. | 52985. | 28000. |
| 70 | 142. | 1834.6 | 271.7 | 103271. | 52168. | 445628. | 1217391. | 445610. | 1217476. | 53165. | 26760. |
| 71 | 144. | 1834.1 | 273.1 | 101177. | 50189. | 445630. | 1217387. | 445611. | 1217471. | 52081. | 25735. |
| 72 | 146. | 1833.2 | 275.2 | 105781. | 56877. | 445633. | 1217381. | 445612. | 1217465. | 54466. | 29199. |
| 73 | 148. | 1833.1 | 277.2 | 105325. | 57838. | 445633. | 1217374. | 445614. | 1217458. | 54230. | 29697. |
| 74 | 150. | 1832.3 | 279.5 | 98000. | 47192. | 445635. | 1217367. | 445615. | 1217451. | 50436. | 24183. |
| 75 | 152. | 1831.9 | 281.2 | 90976. | 42361. | 445637. | 1217361. | 445617. | 1217445. | 46797. | 21680. |
| 76 | 154. | 1830.6 | 282.6 | 99412. | 50021. | 445641. | 1217358. | 445618. | 1217441. | 51168. | 25648. |
| 77 | 156. | 1829.9 | 285.2 | 100796. | 66012. | 445643. | 1217349. | 445620. | 1217433. | 51885. | 33932. |
| 78 | 158. | 1831.5 | 287.4 | 94070. | 65442. | 445638. | 1217340. | 445622. | 1217425. | 48401. | 33637. |
| 79 | 160. | 1830.4 | 289.3 | 99616. | 66481. | 445641. | 1217335. | 445623. | 1217419. | 51274. | 34175. |
| 80 | 162. | 1828.1 | 291.1 | 104735. | 56326. | 445649. | 1217331. | 445624. | 1217414. | 53926. | 28915. |
| 81 | 164. | 1828.9 | 293.1 | 93753. | 64126. | 445646. | 1217323. | 445626. | 1217407. | 48238. | 32956. |
| 82 | 166. | 1828.7 | 295.2 | 97060. | 63602. | 445646. | 1217316. | 445628. | 1217400. | 49951. | 32685. |
| 83 | 168. | 1827.2 | 297.5 | 93157. | 43312. | 445651. | 1217310. | 445629. | 1217393. | 47929. | 22174. |
| 84 | 170. | 1828.2 | 299.7 | 83310. | 54378. | 445648. | 1217301. | 445631. | 1217386. | 42828. | 27907. |
| 85 | 172. | 1826.4 | 301.6* | 62522. | 47361. | 445654. | 1217296. | 445632. | 1217380. | 32060. | 24272. |
| 86 | 174. | 1825.2 | 303.5 | 105403. | 57939. | 445658. | 1217291. | 445634. | 1217374. | 54274. | 29752. |
| 87 | 176. | 1825.7 | 305.3 | 90326. | 44991. | 445656. | 1217284. | 445635. | 1217368. | 46464. | 23044. |
| 88 | 178. | 1825.0 | 307.5 | 92640. | 48754. | 445658. | 1217277. | 445637. | 1217361. | 47663. | 24994. |
| 89 | 180. | 1824.5 | 309.4 | 93799. | 52621. | 445660. | 1217271. | 445639. | 1217355. | 48263. | 26997. |
| 90 | 182. | 1825.2 | 311.4 | 90736. | 45406. | 445657. | 1217264. | 445640. | 1217349. | 46677. | 23259. |
| 91 | 184. | 1823.9 | 313.4 | 86256. | 38661. | 445662. | 1217258. | 445642. | 1217342. | 44356. | 19765. |
| 92 | 186. | 1823.1 | 315.9 | 93013. | 44196. | 445664. | 1217251. | 445644. | 1217334. | 47857. | 22633. |
| 93 | 188. | 1821.8 | 318.1 | 101368. | 54468. | 445668. | 1217244. | 445645. | 1217327. | 52186. | 27954. |
| 94 | 190. | 1822.0 | 320.8 | 104634. | 67960. | 445668. | 1217235. | 445648. | 1217319. | 53878. | 34944. |
| 95 | 192. | 1820.8 | 323.3 | 85960. | 62040. | 445672. | 1217228. | 445650. | 1217311. | 44204. | 31878. |
| 96 | 194. | 1820.0 | 326.2 | 75456. | 55731. | 445674. | 1217218. | 445652. | 1217302. | 38762. | 28609. |
| 97 | 196. | 1820.2 | 328.9 | 55074. | 41312. | 445674. | 1217209. | 445654. | 1217293. | 28203. | 21139. |
| 98 | 198. | 1818.5 | 331.8 | 56601. | 43581. | 445679. | 1217201. | 445657. | 1217284. | 28994. | 22315. |
| 99 | 200. | 1817.1 | 334.8 | 41716. | 32880. | 445684. | 1217192. | 445659. | 1217275. | 21283. | 16771. |
| 100 | 202. | 1816.3 | 337.5 | 43710. | 33666. | 445687. | 1217183. | 445662. | 1217266. | 22316. | 17178. |
| 101 | 204. | 1814.1 | 340.5 | 25112. | 19875. | 445694. | 1217175. | 445665. | 1217257. | 12681. | 10034. |
| 102 | 206. | 1812.2 | 343.7 | 20933. | 16963. | 445700. | 1217166. | 445669. | 1217247. | 10516. | 8525. |
| 103 | 208. | 1812.5 | 346.8 | 21475. | 17336. | 445700. | 1217155. | 445672. | 1217237. | 10797. | 8718. |

Figure 6. Sample of Printed Output of RAPLOT II Processed Data for One RIST Data File

```
     PT MUGU GROIN SITE  BACKGROUNT SURVEY 1  23/09/69  1445                                         F

BEACON 1    228153.N  1648821.E      BEACON 2   227348.N  1649710.E

SQUARE DIST BETWEEN =  0.14383460E 07      DISTANCE BETWEEN =      1199.
SINE = -0.67121892E 00      COSINE =  0.74125916E 00
INJECTION TIME =10. 0.             CLOCK SET AT14.45.      DIGITIZING INTERVAL = 2.SECONDS
DAYS ELAPSED SINCE INJECTION = 0.
HALF-LIFE OF ISOTOPE =    3.CODAYS     DECAY FACTOR =  0.96270442E-02     TIME-DELAY FACTOR =    4.75HOURS
 .   CABLE LENGTH = 75.           MEAN WATER DEPTH = 12.            BOAT LENGTH = 12.
     DISTANCE FROM RADAR MAST TO DETECTOR =  86.0FEET.


                                     PLOTS GENERATED
     TRACKLINE    1             BACKGROUND RADIATION     1           CORRECTED RADIATION   -0


               SUMMARY STATISTICS OF BACKGROUND RADIATION COUNT RATE
     EST. BKG. COUNTS/SEC.        75.
     MEAN BKG. COUNTS/SEC.        78.
     STD. DEV. COUNTS/SEC.         9.


   MAXIMUM COORD          228192.N          1649201.E


   MINIMUM COORD          226291.N          1647486.E
```

Figure 7. Printed Output of RAPLOT III Program Control Parameters and Summary Statistics for One Data File

PT MUGU GROIN SITE BACKGROUNT SURVEY 1 23/09/69 1445

| LINE | TIME | DISTANCE TO BEACON | | BOAT COORDTNATES | | BALL COORDINATES | | UNCORRECTED | CORRECTED | DEPTH |
|---|---|---|---|---|---|---|---|---|---|---|
| | SEC | 1 | 2 | NORTH | EAST | NORTH | EAST | RADIATION | COUNTS/SEC | FEET |
| 0 | 2. | | | 228177. | 1648434. | 228092. | 1648429. | | 75. | 0. |
| 1 | 4. | | | 228192. | 1648435. | 228106. | 1648430. | | 92. | 0. |
| 2 | 6. | | | 228182. | 1648427. | 228106. | 1648430. | | 106. | 0. |
| 3 | 8. | | | 228181. | 1648424. | 228106. | 1648430. | | 88. | 0. |
| 4 | 10. | | | 228171. | 1648419. | 228106. | 1648430. | | 102. | 0. |
| 5 | 12. | | | 228168. | 1648416. | 228106. | 1648430. | | 97. | 0. |
| 6 | 14. | | | 228160. | 1648408. | 228106. | 1648430. | | 106. | 0. |
| 7 | 16. | | | 228145. | 1648406. | 228106. | 1648430. | | 104. | 0. |
| 8 | 18. | | | 228145. | 1648402. | 228106. | 1648430. | | 96. | 0. |
| 9 | 20. | | | 228141. | 1648398. | 228106. | 1648430. | | 92. | 0. |
| 10 | 22. | | | 228130. | 1648394. | 228106. | 1648430. | | 101. | 0. |
| 11 | 24. | | | 228118. | 1648392. | 228106. | 1648430. | | 100. | 0. |
| 12 | 26. | | | 228119. | 1648385. | 228106. | 1648430. | | 92. | 0. |
| 13 | 28. | | | 228124. | 1648379. | 228106. | 1648430. | | 113. | 0. |
| 14 | 30. | | | 228108. | 1648373. | 228106. | 1648430. | | 96. | 0. |
| 15 | 32. | | | 228105. | 1648361. | 228106. | 1648430. | | 100. | 0. |
| 16 | 34. | | | 228101. | 1648354. | 228106. | 1648430. | | 71. | 0. |
| 18 | 38. | | | 228072. | 1648336. | 228101. | 1648416. | | 70. | 0. |
| 19 | 40. | | | 228063. | 1648325. | 228096. | 1648404. | | 74. | 0. |
| 20 | 42. | | | 228050. | 1648316. | 228090. | 1648392. | | 59. | 0. |
| 21 | 44. | | | 228040. | 1648308. | 228084. | 1648382. | | 57. | 0. |
| 22 | 46. | | | 228023. | 1648301. | 228075. | 1648370. | | 72. | 0. |
| 23 | 48. | | | 228015. | 1648295. | 228069. | 1648362. | | 79. | 0. |
| 24 | 50. | | | 228011. | 1648286. | 228063. | 1648355. | | 63. | 0. |
| 25 | 52. | | | 228005. | 1648278. | 228057. | 1648347. | | 60. | 0. |
| 26 | 54. | | | 227994. | 1648273. | 228050. | 1648339. | | 76. | 0. |
| 27 | 56. | | | 227989. | 1648266. | 228044. | 1648332. | | 74. | 0. |
| 28 | 58. | | | 227992. | 1648254. | 228040. | 1648325. | | 66. | 0. |
| 29 | 60. | | | 227970. | 1648251. | 228029. | 1648314. | | 71. | 0. |
| 30 | 62. | | | 227970. | 1648241. | 228024. | 1648307. | | 76. | 0. |
| 31 | 64. | | | 227960. | 1648232. | 228015. | 1648298. | | 81. | 0. |
| 32 | 66. | | | 227957. | 1648220. | 228009. | 1648288. | | 75. | 0. |
| 33 | 68. | | | 227942. | 1648214. | 227999. | 1648278. | | 63. | 0. |
| 34 | 70. | | | 227935. | 1648204. | 227992. | 1648269. | | 66. | 0. |
| 35 | 72. | | | 227919. | 1648205. | 227983. | 1648262. | | 80. | 0. |
| 36 | 74. | | | 227921. | 1648199. | 227982. | 1648260. | | 80. | 0. |
| 37 | 76. | | | 227913. | 1648197. | 227976. | 1648255. | | 78. | 0. |
| 38 | 78. | | | 227914. | 1648192. | 227974. | 1648253. | | 64. | 0. |
| 39 | 80. | | | 227906. | 1648185. | 227967. | 1648246. | | 48. | 0. |
| 40 | 82. | | | 227895. | 1648179. | 227958. | 1648237. | | 52. | 0. |
| 41 | 84. | | | 227894. | 1648173. | 227955. | 1648234. | | 68. | 0. |
| 42 | 86. | | | 227881. | 1648173. | 227947. | 1648228. | | 64. | 0. |
| 43 | 88. | | | 227886. | 1648164. | 227945. | 1648226. | | 82. | 0. |
| 44 | 90. | | | 227875. | 1648157. | 227936. | 1648217. | | 59. | 0. |
| 45 | 92. | | | 227862. | 1648152. | 227927. | 1648208. | | 56. | 0. |
| 46 | 94. | | | 227854. | 1648147. | 227920. | 1648203. | | 64. | 0. |
| 47 | 96. | | | 227856. | 1648141. | 227918. | 1648201. | | 74. | 0. |
| 48 | 98. | | | 227845. | 1648138. | 227910. | 1648194. | | 75. | 0. |
| 49 | 100. | | | 227833. | 1648134. | 227901. | 1648187. | | 57. | 0. |
| 50 | 102. | | | 227825. | 1648128. | 227893. | 1648181. | | 55. | 0. |

Figure 8. Sample of Printed Output of RAPLOT III Processed Data for One RIST Data File

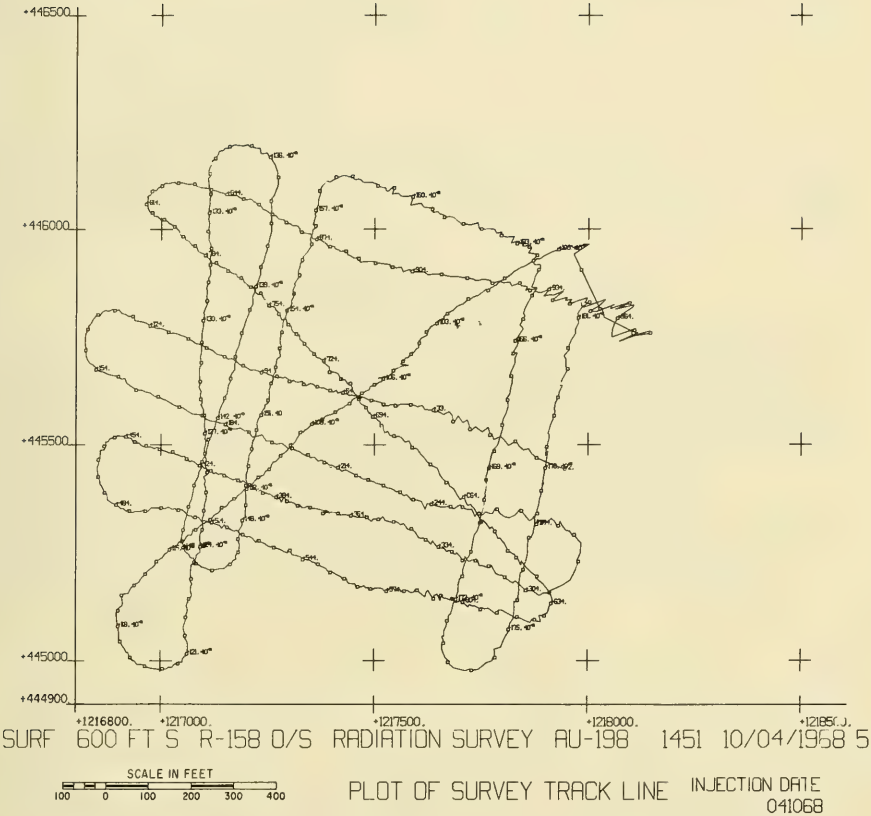



Figure 9. Trackline Plot Produced on Benson-Lehner Plotter by Subroutine BENLH2 of RAPLOT II

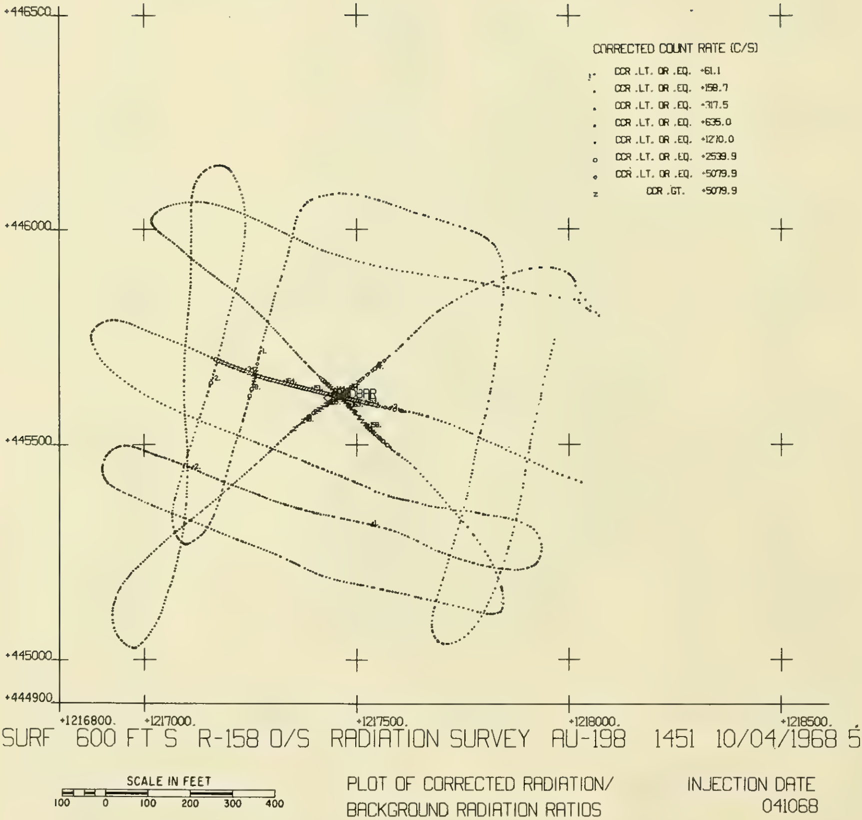



Figure 10. Plot of Corrected Radiation Data Produced on Benson-Lehner Plotter by Subroutine BENLH2 of RAPLOT II

The graphical output from RAPLOT III is produced on the Stromberg-Carlson 4020 computer recorder. The technique for getting the plots is somewhat the same as the Benson-Lehner plotter in that the plot commands are written out on magnetic tape and are then used off-line to generate the plots. There is a highly developed software package that goes with the S-C 4020 and if it is planned to use this method of generating plots, the Programmers' Reference Manual for the S-C 4020 should be used. Figure 11 is a trackline plot produced on the computer recorder at the Pacific Missile Range data processing center at Point Mugu. Figure 12 is a plot of uncorrected radiation data that was also produced there.

3. Magnetic Tape Output

The processed data is stored on magnetic tape for future reference by the calls to the NTRAN subroutine. The arrays written out are: LEGEND, sequence number (NMBR), coordinates of radiation location (NCORD and ECORD), and corrected radiation data (CCR). This procedure has been eliminated from RAPLOT III.

## Section F. INSTRUCTIONS FOR RUNNING PROGRAM

An example of a job deck setup for running RAPLOT II is shown in Figure 13. Further instructions on running jobs are in the 1108 EXEC II Programmers' Reference Manual. Running time depends on the number of files being processed and the number of records in each file. Figure 14 shows a graph of UNIVAC 1108 central processing unit time to process one file versus the number of records in the file.

For running version III on the IBM 7094, consult the IBM reference manuals for FORTRAN IV and the system monitor (IBSYS). It may also be useful to have a copy of the Programmers' Reference Manual for the S-C 4020 Computer Recorder.

## Section G. RADIATION CONTOURING PROGRAM

Present programming effort is directed toward completing RADCON, a FORTRAN V program for drawing contour maps of radiation data. The input for this program will be the files of processed data on magnetic tape that have been generated by RAPLOT II. If necessary, two or more data files may be combined to provide the input for one contour map. The radiation data are first smoothed by a moving average (LINAVE) procedure and then interpolated over a uniform grid by a weighted least-squares numerical approximation (NUPRX). The resulting grid is then contoured at equally spaced intervals of the gridded values. There are also options for transforming the radiation data, although the number of options and types of transformation is still undecided.

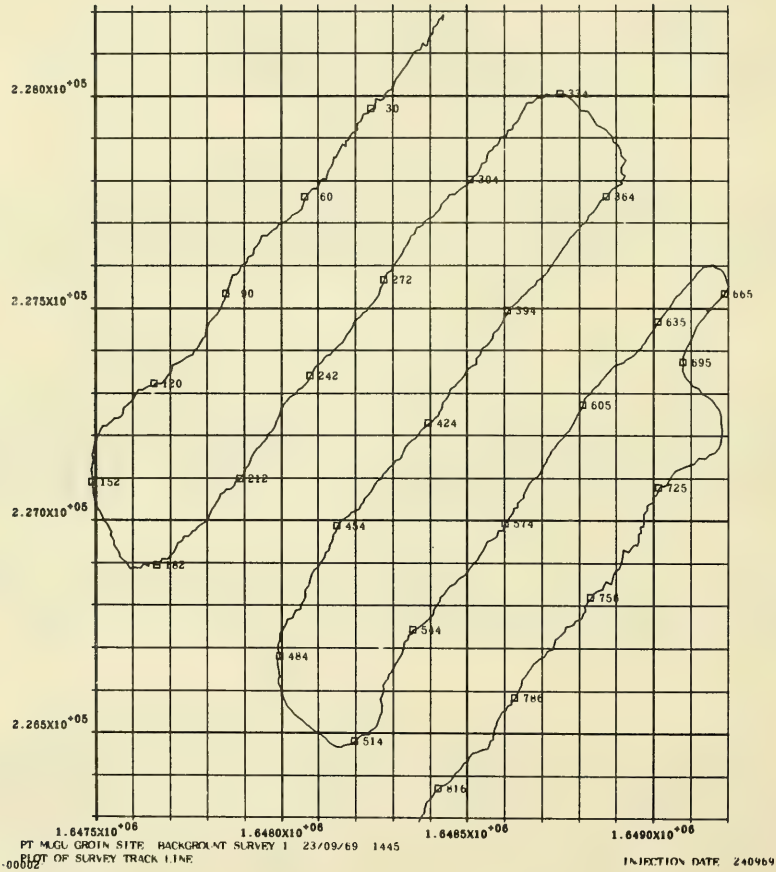



Figure 11. Trackline Plot Produced on S-C 4060 Computer Recorder by Subroutine TRACK of RAPLOT III

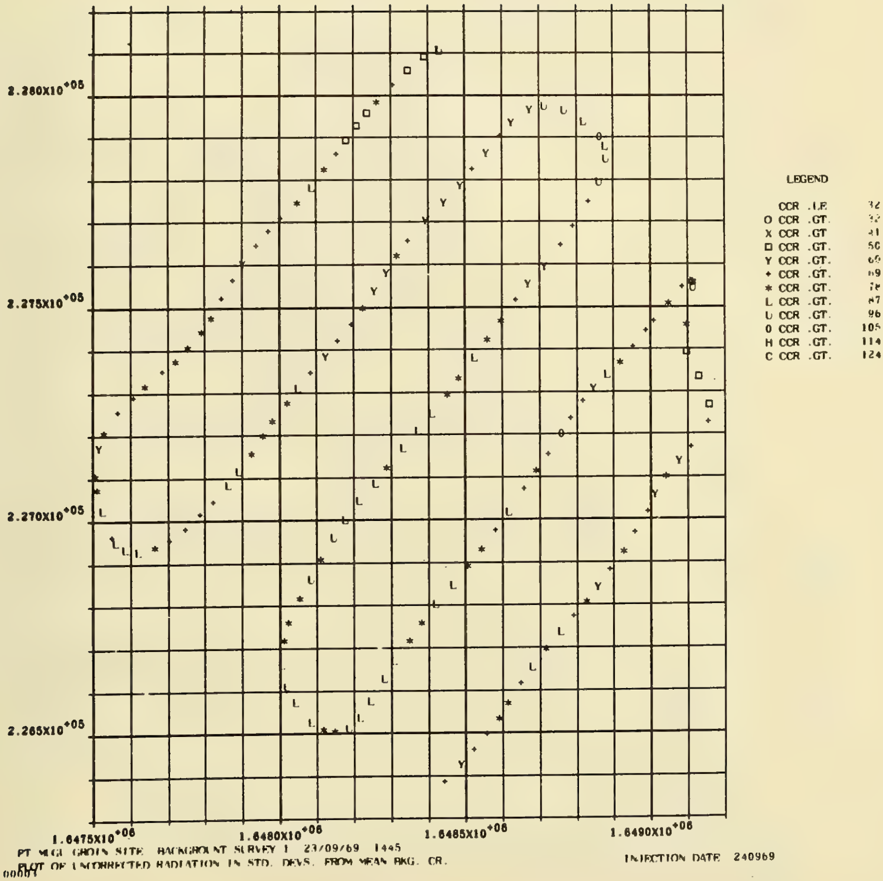



Figure 12. Plot of Uncorrected Radiation Data Produced on S-C 4060 Computer Records by Subroutine TRACK of RAPLOT III

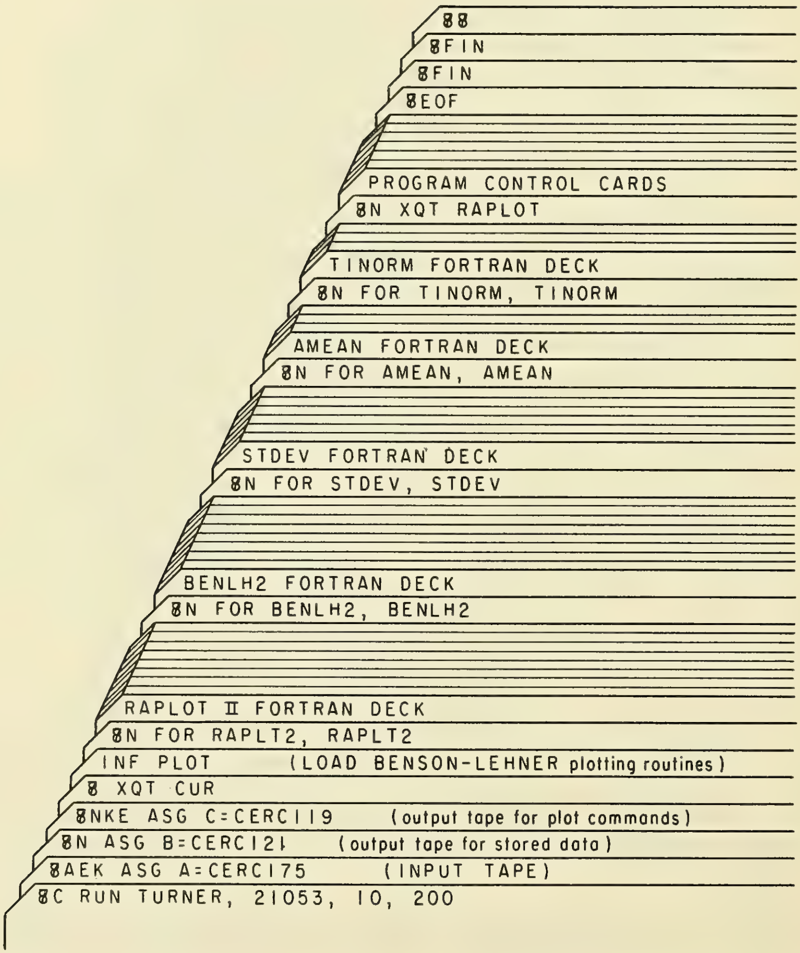



Figure 13. Example of a RAPLOT II Job Deck Setup for UNIVAC 1108 Running under EXEC II

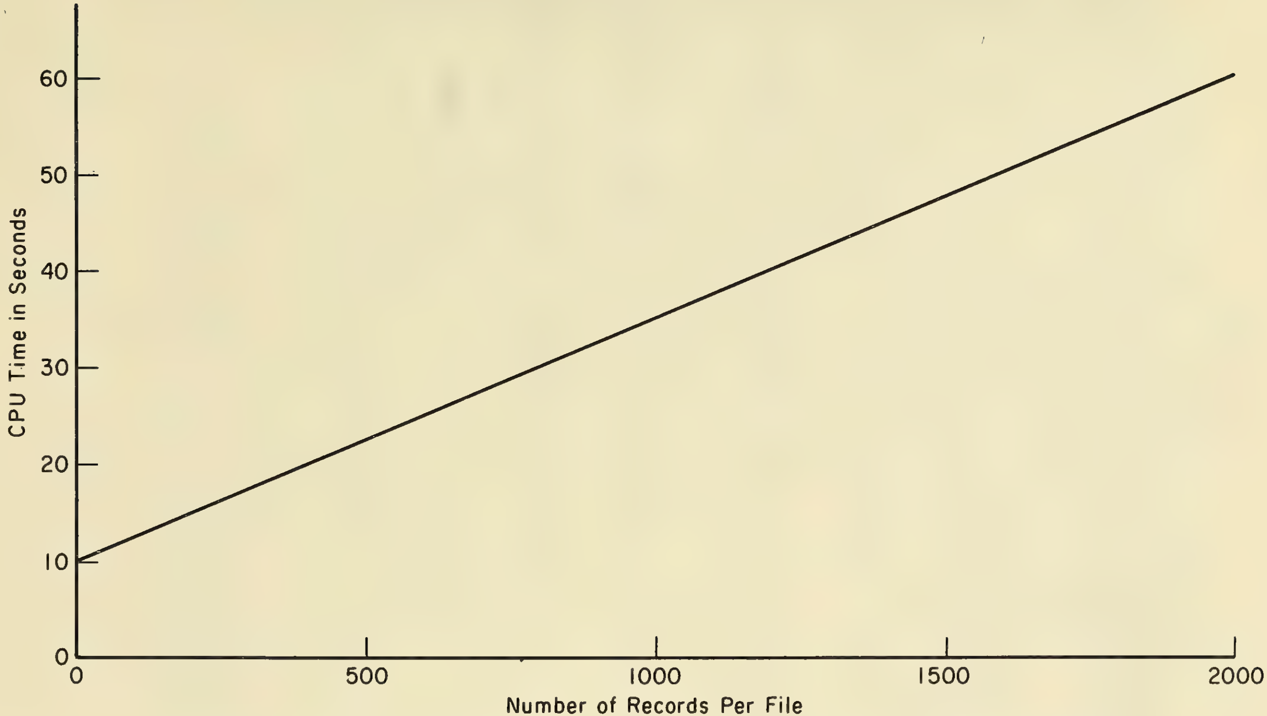



Figure 14. Graph of CPU Time Required to Plot One Data File Versus the Number of Records in the File.

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## APPENDIX A

## LISTING AND INDEX OF RAPLOT II PROGRAM

The source deck has been analyzed routine-by-routine and a directory of all statement numbers and variable names used in the source deck. The symbols are listed numerically and alphabetically. Beside each symbol appears line numbers followed by a code which designates where and how the symbol was referenced. The codes used are as follows:

| Code | Meaning |
|---|---|
| Blank | A simple reference, such as the use of a statement number in an IF statement or a variable used in an arithmetic statement. |
| = | Arithmetic definition of a variable which appears on the left of an = sign. |
| * | Statement number defined at this line. |
| AG | Variable appears as an argument in a subroutine or function statement or as an argument in a CALL statement. |
| CO | Variable appears in a COMMON statement. |
| CX | Variable appears in a COMPLEX statement. |
| DA | Variable appears in a DATA statement. |
| DB | Variable appears in a DOUBLE PRECISION statement. |
| DI | Variable appears in a DIMENSION statement. |
| EQ | Variable appears in an EQUIVALENCE statement. |
| EX | Function name appears in an EXTERNAL statement. |
| IN | Variable appears in an INTEGER statement. |
| LG | Variable appears in a LOGICAL statement. |
| NM | Variable appears in a NAMELIST statement. |
| PR | Variable or FORMAT number appears in a PRINT statement. |
| PU | Variable or FORMAT number appears in a PUNCH statement. |
| RD | Variable or FORMAT number appears in a READ statement. |
| RL | Variable appears in a REAL statement. |
| WR | Variable or FORMAT number appears in a WRITE statement. |

```
          C          PROGRAM --  RAPLOT II
          C     THE PURPOSE OF THIS PROGRAM IS TO REDUCE THE RADIOACTIVITY SURVEY
          C     DATA FROM THE RIST PROJECT AND PLOT THE SURVEY ON A BENSON-LEHNER
          C     INCREMENTAL PLOTTER.  THE FOLLOWING PLOTS ARE THE OUTPUT'
          C        TRACKLINE FOLLOWED BY SURVEY VESSEL
          C        PLOT OF UNCORRECTED RADIATION VALUES (BACKGROUND SURVEY)
          C        SYMBOL PLOT OF RADIATION VALUES CORRECTED FOR BACKGROUND AND
          C                  DECAY SINCE INJECTION TIME.
          C        PROGRAMMER:  PHILIP A. TURNER
          C                     GEOLOGY BRANCH
          C                     U S ARMY COASTAL ENGINEERING RESEARCH CENTER
          C                     5201 LITTLE FALLS ROAD
          C                     WASHINGTON, D. C.   20016
          C        COMPLETED IN JANUARY  1969
          C
          C     FORMAT AND ENTRIES ON DATA CONTROL CARD
          C           COL  1- 3  CABLE LENGTH IN FEET TO THE NEAREST FOOT.
          C           COL  4- 6  WATER DEPTH PLUS FREEBOARD TO THE NEAREST FOOT.
          C           COL  7- 9  DISTANCE FROM RADAR MAST TO CABLE STANCHION IN FEET
          C                      TO THE NEAREST FOOT.
          C           COL 10-16  ESTIMATED BACKGROUND COUNT RATE IN COUNTS/SEC FOR
          C                      CHANNEL 1.
          C           COL 17-23  ESTIMATED BACKGROUND COUNT RATE IN COUNTS/SEC FOR
          C                      CHANNEL 2.
          C           COL 25-28  TIME OF INJECTION IN HOURS AND MINUTES.
          C           COL 29-31  THE NUMBER OF DAYS SINCE THE INJECTION
          C           COL 32-36  THE HALF LIFE OF THE RADIOISOTOPE IN DAYS.
          C                           THE DECIMAL POINT MUST BE PUNCHED IN.
          C           COL 37-40  THE TIME WHEN THE SURVEY WAS STARTED, IN HOURS AND
          C                           MINUTES.
          C           COL 41-42  TIME (IN SECONDS) BETWEEN SUCCESSIVE FIXES
          C           COL 44-50  BEACON1 NORTH COORD/ LAMBERT COORDINATES OF RADAR
          C           COL 52-58  BEACON1  EAST COORD/ BEACONS TO THE NEAREST FOOT.
          C           COL 60-66  BEACON2 NORTH COORD/ BEACON1 IS ALWAYS UPCOAST.
          C           COL 68-74  BEACON2  EAST COORD/
          C           COL 75-77  THE NUMBER OF LINES OF DATA TO BE SKIPPED AT THE
          C                          BEGINNING OF A DATA SET IN ORDER TO AVOID
          C                          READING IN SOME BAD DATA.
          C     FORMAT AND ENTRIES ON PLOT CONTROL CARD
          C           COL  1- 3  PLOT OPTION CONTROL.  TO USE, PUNCH THE NUMERAL 1
          C                      IN THE COLUMN INDICATED.
          C                      1 = PLOT TRACKLINE FOLLOWED BY SURVEY VESSEL.
          C                      2 = PLOT UNCORRECTED RADIATION VALUES.
          C                      3 = PLOT RADIATION VALUES CORRECTED FOR BACKGROUND
          C                          AND DECAY SINCE TIME ZERO.
          C                      4 = UNUSED. LEAVE BLANK.
          C           COL  5-14  MAP SCALE EXPRESSED IN FEET PER INCH
          C           COL 16-17  OPTION 1 / USE WHEN SPOTTING DATA FOR EACH PLOT
          C           COL 18-19    ]    2 / OPTION.  USER CAN SPECIFY THAT EVERY NTH
          C           COL 20-21    ]    4 / POINT BE PLOTTED.  IF LEFT BLANK, THE
          C                                  PROGRAM ASSUMES EVERY POINT IS TO BE
          C                                  PLOTTED.
          C           COL 23-32  INTERVALS ON THE COORDINATE GRID AT WHICH TICK
          C                      MARKS WITH THE LAMBERT COORDINATES WILL BE POSTED.
          C                      IF FIELD IS LEFT BLANK, PROGRAM WILL ASSUME THAT
          C                      NO TICK MARKS ARE TO BE PLOTTED AND POSTED.
          C           COL 34-43  BEACON 1 / INJECTION SITE. DISTANCE IN METERS TO
          C           COL 45 54  BEACON 2 / THE NAMED BEACONS. IF FIELDS ARE LEFT
          C                                  BLANK, SITE IS NOT PLOTTED.
          C           COL 56-61  DAY,MONTH AND YEAR THE SAND WAS INJECTED
          C     FORMAT AND ENTRIES ON PLOT IDENTIFICATION CARD
          C           COL  1-78  THIS FIELD WILL BE PLOTTED ON THE LOWER MARGIN OF
          C                      THE MAP.
          C           COL 80     PUNCH 'T' HERE ON THE LAST DATA SET.
1               COMMON NOPT(4),SCALE,NPLT(3),GRID,SITEN,SITEE,INDATE,LEGEND(13),BE
               1AC1N,BEAC1E,BEAC2N,BEAC2E,LINE,BGCR(2),SIGMA(2),NBAR,EBAR,NENTRY,N
               2MAX,NMIN,EMAX,EMIN
2               REAL NORTH(2200),NCORD(2200),NBAR,NMAX,NMIN
3               DIMENSION NMBR(2200), TIME(2200), D(2,2200), EAST(2200), ECORD(220
               10), RAD(2,2200), CCR(2,2200), L(4), IERR(2200), BKG(2), FATH(2200)
               2, ISIGN(3)
4               INTEGER SENTNL(7),WORD1,WORD2,BLANK,AS
5               LOGICAL JOBEND
          C
          C     NTAPE IS THE NUMBER FOR THE INPUT TAPE CONTAINING THE SURVEY DATA
          C     ITAPE IS THE UNIT ON WHICH THE PROCESSED DATA IS WRITTEN OUT
          C
6               DATA WORD1,WORD2,NTAPE,ITAPE,COR1,COR2,BLANK,AS/6HEND OF,6H DATA ,
               17,8,2.9,2.8,6H      ,1H*/
```

```
         C
         C      READ IN DATA CONTROL CARD
         C
   7     10     IF (L(1).NE.-1) GO TO 20
   8            GO TO 10
   9     20     IF (L(1).LT.-1) GO TO 770
  10            READ (5,780) CABLE,DEPTH,BOAT,BKG,ZHR,ZMIN,DAYS,HLIFE,SETIME,RMIN,
               1SEC,BEAC1N,BEAC1E,BEAC2N,BEAC2E,ISKIP
         C
         C      READ IN PLOT CONTROL PARAMETERS
         C
  11            READ (5,790) NOPT,SCALE,(NPLT(I),I=1,3),GRID,DUMP1,DUMP2,INDATE
  12            DO 40 I=1,3
  13            IF (NPLT(I)) 30,30,40
  14     30     NPLT(I)=1
  15     40     CONTINUE
         C
         C      READ IN PLOT LEGEND
         C
  16            READ (5,800) LEGEND,JOBEND
  17            WRITE (6,810) LEGEND,JOBEND
  18            WRITE (6,820) BEAC1N,BEAC1E,BEAC2N,BEAC2E
         C
         C      COMPUTE PROGRAM PARAMETERS FROM DATA CONTROL CARD ENTRIES
         C
  19            SQDSTB=(BEAC2N-BEAC1N)**2+(BEAC2E-BEAC1E)**2
  20            DISTB=SQRT(SQDSTB)
  21            WRITE (6,830) SQDSTB,DISTB
  22            SINE=(BEAC2N-BEAC1N)/DISTB
  23            COSINE=(BEAC2E-BEAC1E)/DISTB
  24            WRITE (6,840) SINE,COSINE
  25            WRITE (6,850) ZHR,ZMIN,SETIME,RMIN,SEC,DAYS
  26            ZHR=ZHR+ZMIN/60.
  27            SETIME=SETIME+RMIN/60.
  28            DELAY=SETIME+DAYS*24.-ZHR
  29            IF (HLIFE.GT.0.0) DECAY=ALOG(2.)/(HLIFE*24.)
  30            WRITE (6,860) HLIFE,DECAY,DELAY
  31            WRITE (6,870) CABLE,DEPTH,BOAT
  32            CABLE=BOAT+SQRT(CABLE**2-DEPTH**2)
  33            WRITE (6,880) CABLE
  34            WRITE (6,890) (NOPT(I),I=1,3)
         C
         C      COMPUTE COORDINATES OF THE INJECTION SITE FROM THE DISTANCES FROM
         C      THE BEACONS
         C
  35            IF (DUMP1) 80,80,50
  36     50     DUMP1=(DUMP1+COR1)*3.28083
  37            DUMP2=(DUMP2+COR2)*3.28083
  38            DX1=(SQDSTB+DUMP1*DUMP1-DUMP2*DUMP2)/(DISTB*2.)
  39            DY1=DUMP1*DUMP1-DX1*DX1
  40            IF (DY1) 60,60,70
  41     60     SITEN=-999999.
  42            WRITE (6,900)
  43            GO TO 80
  44     70     DY1=-SQRT(DY1)
  45            SITEE=DX1*COSINE-DY1*SINE+BEAC1E
  46            SITEN=DX1*SINE+DY1*COSINE+BEAC1N
  47            WRITE (6,910) SITEN,SITEE
         C
         C      TEST FILE SENTINEL TO BE SURE THAT THE CORRECT DATA FILE IS BEING
         C      READ IN
         C
  48     80     READ (NTAPE) SENTNL
  49            IF (SENTNL(1).EQ.WORD1.AND.SENTNL(2).EQ.WORD2) GO TO 730
  50            IF (SENTNL(1).EQ.LEGEND(12).AND.SENTNL(2).EQ.LEGEND(13)) GO TO 90
  51            CALL NTRAN (NTAPE,8,1)
  52            GO TO 80
  53     90     WRITE (6,920) SENTNL
         C
         C      READ IN THE DATA FILE FROM ONE RIST SURVEY
         C
  54     100    IF (L(2).NE.-1) GO TO 110
  55            GO TO 100
  56     110    IF (L(2).LT.-1) GO TO 770
  57            CALL NTRAN (ITAPE,1,13,LEGEND,L(1))
  58            READ (NTAPE) LINE,(NMBR(N),TIME(N),D(1,N),D(2,N),RAD(1,N),RAD(2,N)
               1,FATH(N),N=1,LINE)
  59            CALL NTRAN (NTAPE,8,1)
  60            IERR(1)=0
  61            DO 130 N=2,LINE
```

```
            IERR(N)=0
      C
      C     CHECK TO SEE THAT LINE NUMBERS AND TIMES OF FIXES ARE IN MONOTONIC
      C     ASCENDING SEQUENCE.
      C
            IF (NMBR(N).LE.NMBR(N-1)) NMBR(N)=NMBR(N-1)+1
            IF (TIME(N)-TIME(N-1)) 120,120,130
      120   TIME(N)=TIME(N-1)+SEC
      130   CONTINUE
            IF (ISKIP.LE.0) GO TO 160
      C
      C     SKIP LEADING CARD IMAGES THAT CONTAIN BAD DATA.
      C
            NSTART=ISKIP+1
            DO 150 N=NSTART,LINE
            NMBR(N-ISKIP)=NMBR(N)
            TIME(N-ISKIP)=TIME(N)
            DO 140 I=1,2
            D(I,N-ISKIP)=D(I,N)
      140   RAD(I,N-ISKIP)=RAD(I,N)
      150   FATH(N-ISKIP)=FATH(N)
            LINE=LINE-ISKIP
      160   MSTOP=LINE-1
      C
      C     CHECK DISTANCES TO RADAR BEACONS FOR ERRORS.  IF DISTANCE/TIME
      C     FOR SUCCESSIVE BEACON RANGES INDICATE A SHIP SPEED .GT. 6 KNOTS
      C     (3.09 METERS/SEC),RANGE IS IN ERROR.
      C
            DO 270 I=1,2
            DO 200 M=1,MSTOP
            IF (D(I,M)) 200,200,170
      170   NSTART=M+1
            DO 190 N=NSTART,LINE
            IF (ABS(D(I,N)-D(I,M))-(TIME(N)-TIME(M))*3.08865) 200,200,180
      180   D(I,N)=-1.
            IERR(N)=IERR(N)+1
      190   CONTINUE
      200   CONTINUE
            DO 260 M=1,MSTOP
            IF (D(I,M)) 210,210,260
      210   NSTART=M
      C
      C     CORRECT ERRONEOUS BEACON RANGES BY LINEAR INTERPOLATION (ON TIME)
      C     BETWEEN NON-ERRONEOUS RANGES.
      C
            DO 230 N=NSTART,LINE
            IF (D(I,N)) 230,230,220
      220   NSTOP=N
            GO TO 240
      230   CONTINUE
      240   DTIME=TIME(NSTOP)-TIME(NSTART-1)
            DD1=D(I,NSTOP)-D(I,NSTART-1)
            N=NSTART
      250   D(I,N)=D(I,NSTART-1)+DD1*(TIME(N)-TIME(NSTART-1))/DTIME
            N=N+1
            IF (N-NSTOP) 250,260,260
      260   CONTINUE
      270   CONTINUE
      C
      C     COMPUTE POSITION OF SHIP FROM DISTANCES FROM THE TWO BEACONS
      C
            LAG=0
            DO 300 N=1,LINE
      C
      C     MAKE CONSTANT CORRECTION FOR CUBIC AUTOTAPE INTERROGATOR
      C     AND CONVERT TO FEET
      C
            DFT1=(D(1,N)+COR1)*3.28083
            DFT2=(D(2,N)+COR2)*3.28083
            DX1=(SQDSTB+DFT1*DFT1-DFT2*DFT2)/(2.*DISTB)
            DY1=DFT1*DFT1-DX1*DX1
      C
      C     CHECK FOR IMAGINARY ROOT.
      C
            IF (DY1) 280,280,290
      280   IERR(N)=IERR(N)+4
            LAG=LAG+1
            GO TO 300
      290   DY1=-SQRT(DY1)
```

```
C
C     ROTATE COORDINATES AND TRANSLATE INTO CALIFORNIA LAMBERT COORDINAT
C     SYSTEM
C
      EAST(N)=DX1*COSINE-DY1*SINE+BEAC1E
      NORTH(N)=DX1*SINE+DY1*COSINE+BEAC1N
  300 CONTINUE
      IF (LAG.EQ.0) GO TO 360
      ASSIGN 360 TO KEY
C
C     ELIMINATE DATA SETS FOR WHICH AN
C     IMAGINARY FIX WAS OBTAINED
C
  310 LAG=0
      DO 350 N=1,LINE
      IF (IERR(N)-4) 330,320,320
  320 LAG=LAG+1
      GO TO 350
  330 NMBR(N-LAG)=NMBR(N)
      TIME(N-LAG)=TIME(N)
      DO 340 I=1,2
      D(I,N-LAG)=D(I,N)
  340 RAD(I,N-LAG)=RAD(I,N)
      EAST(N-LAG)=EAST(N)
      NORTH(N-LAG)=NORTH(N)
      IERR(N-LAG)=IERR(N)
  350 CONTINUE
      LINE=LINE-LAG
      GO TO KEY,(360,430)
C
C     CHECK NORTH AND EAST COORDINATES FOR
C     EXTREME VALUES BY CHAUVENET'S CRITERION
C
  360 NBAR=-1.
      CALL STDEV (NORTH,LINE,NBAR,SDNRTH)
      EBAR=-1.
      CALL STDEV (EAST,LINE,EBAR,SDEAST)
      ALPHA=1.-1./FLOAT(2*LINE)
      CHVR=TINORM(ALPHA,$365)
      GO TO 370
  365 CHVR=5.0
      WRITE (6,930) ALPHA
  370 GATE1=EBAR-CHVR*SDEAST
      GATE2=EBAR+CHVR*SDEAST
      GATEN1=NBAR-CHVR*SDNRTH
      GATEN2=NBAR+CHVR*SDNRTH
      LAG=0
      DO 420 N=1,LINE
      IF (EAST(N)-GATE1) 410,380,380
  380 IF (EAST(N)-GATE2) 390,390,410
  390 IF (NORTH(N)-GATEN1) 410,400,400
  400 IF (NORTH(N)-GATEN2) 420,420,410
  410 IERR(N)=IERR(N)+4
      LAG=LAG+1
  420 CONTINUE
      ASSIGN 430 TO KEY
C
C     ELIMINATE ANY DATA SETS THAT HAVE AN EXTREME
C     VALUES OF THE NORTH OR EAST COORDINATES
C
      IF (LAG.GT.0) GO TO 310
C
C     CALL SUBROUTINE FOR PLOTTING THE TRACK OF THE SURVEY VESSEL.
C
  430 NENTRY=1
      CALL NTRAN (ITAPE,1,LINE,NMBR,L(2))
      IF (NOPT(1).EQ.1) CALL BENLH2 (NORTH,EAST,NMBR)
C
C     APPLY A CORRECTION TO ALLOW FOR THE DISTANCE THE DETECTOR IS TOWED
C        ASTERN OF THE SURVEY SHIP.
C
  440 IF (L(3).NE.-1) GO TO 450
      GO TO 440
  450 IF (L(3).LT.-1) GO TO 770
      DNO=NORTH(1)-(NORTH(2)-NORTH(1))
      DEO=EAST(1)-(EAST(2)-EAST(1))
      DENOM=SQRT((NORTH(1)-DNO)**2+(EAST(1)-DEO)**2)
      NCORD(1)=NORTH(1)-CABLE*(NORTH(1)-DNO)/DENOM
      ECORD(1)=EAST(1)-CABLE*(EAST(1)-DEO)/DENOM
      DO 480 N=2,LINE
```

```
      DENOM=SQRT((NORTH(N)-NCORD(N-1))**2+(EAST(N)-ECORD(N-1))**2)
C
C     THE CORRECTION FOR THE DISTANCE BETWEEN VESSEL AND THE DETECTOR
C     IS EQUAL TO 'CABLE' UNLESS THE VESSEL IS LESS THAN 'CABLE' FEET
C     AWAY FROM THE LAST COMPUTED POSITION OF THE DETECTOR VEHICLE.  IN
C     THIS EVENT, THE NEW COMPUTED DETECTOR POSITION IS THE SAME AS
C     THE LAST DETECTOR POSITION
C
      IF (DENOM-CABLE) 470,470,460
  460 NCORD(N)=NORTH(N)-CABLE*(NORTH(N)-NCORD(N-1))/DENOM
      ECORD(N)=EAST(N)-CABLE*(EAST(N)-ECORD(N-1))/DENOM
      GO TO 480
  470 NCORD(N)=NCORD(N-1)
      ECORD(N)=ECORD(N-1)
  480 CONTINUE
      CALL NTRAN (ITAPE,1,LINE,NCORD,LAG,1,LINE,ECORD,L(3))
  490 IF (L(4).NE.-1) GO TO 500
      GO TO 490
  500 IF (L(4).LT.-1) GO TO 770
C
C     CONVERT RADIATION READINGS TO COUNTS PER SECOND
C
      IF (BKG(1)) 650, 650, 505
  505 CCR(2,1)=RAD(2,1)/SEC
      CCR(1,1)=RAD(1,1)/SEC
      DO 510 N=2,LINE
      DO 510 I=1,2
  510 CCR(I,N)=RAD(I,N)/SEC
C
C     COMPUTE THE MEAN AND STANDARD DEVIATION OF THE BACKGROUND COUNT
C     RATE FROM THE RADIATION DATA THAT LIES WITHIN THE LIMITS OF THE
C     ESTIMATED BACKGROUND COUNT RATE SET BY CHAUVENET'S CRITERION.
C
      IF (CCR(1,1).GT.2.*BKG(1)) CCR(1,1)=BKG(1)
      IF (CCR(2,1).GT.2.*BKG(2)) CCR(2,1)=BKG(2)
      ALPHA=1.-1./FLOAT(2*LINE)
      CHVR=TINORM(ALPHA,$515)
      GO TO 520
  515 CHVR=5.
      WRITE (6,930) ALPHA
  520 DO 590 I=1,2
      BGCR(I)=0.0
      SIGMA(I)=0.0
      NCOUNT=0
      GATE1=BKG(I)-CHVR*SQRT(BKG(I)/SEC)
      GATE2=BKG(I)+CHVR*SQRT(BKG(I)/SEC)
      DO 550 N=1,LINE
      IF (CCR(I,N)-GATE1) 550,550,530
  530 IF (CCR(I,N)-GATE2) 540,550,550
  540 NCOUNT=NCOUNT+1
      BGCR(I)=BGCR(I)+CCR(I,N)
  550 CONTINUE
      BGCR(I)=BGCR(I)/FLOAT(NCOUNT)
      DO 580 N=1,LINE
      IF (CCR(I,N)-GATE1) 580,580,560
  560 IF (CCR(I,N)-GATE2) 570,580,580
  570 SIGMA(I)=SIGMA(I)+(CCR(I,N)-BGCR(I))**2
  580 CONTINUE
  590 SIGMA(I)=SQRT(SIGMA(I)/FLOAT(NCOUNT))
      WRITE (6,940) BKG,BGCR,SIGMA
C
C     CALL THE SUBROUTINE FOR PLOTTING UNCORRECTED RADIATION VALUES
C
      NENTRY=2
      IF (NOPT(2).EQ.1) CALL RDPLT2 (NCORD,ECORD,CCR)
      IF (NOPT(3).NE.1) GO TO 650
C
C     CORRECT RADIATION VALUES FOR BACKGROUND COUNT RATE AND TIME-DECAY
C
      SUM=0.0
      SUM2=0.0
      NBAR=0.0
      EBAR=0.0
      DO 620 N=1,LINE
      DO 610 I=1,2
      CCR(I,N)=CCR(I,N)-BGCR(I)
      IF (CCR(I,N) - 3.*SIGMA(I)) 610,610,600
  600 CCR(I,N)=(CCR(I,N)-3.*SIGMA(I))*EXP(DECAY*(DELAY+TIME(N)/3600.))
     1 + 3.*SIGMA(I)
```

```
  610 CONTINUE
      IF (CCR(1,N).LE.0.0) GO TO 620
      SUM=SUM+CCR(1,N)
      SUM2=SUM2+CCR(2,N)
C
C     COMPUTE WEIGHTED MEAN AND STD. DEV. OF ACTIVITY LOCATION
C
      EBAR=EBAR+(ECORD(N)-ECORD(1))*CCR(1,N)
      NBAR=NBAR+(NCORD(N)-NCORD(1))*CCR(1,N)
  620 CONTINUE
      NBAR=NCORD(1)+NBAR/SUM
      EBAR=ECORD(1)+EBAR/SUM
      SDNRTH=0.0
      SDEAST=0.0
      DO 640 N=1,LINE
      IF (CCR(1,N)) 640,640,630
  630 SDNRTH=SDNRTH+(NCORD(N)-NBAR)**2*CCR(1,N)
      SDEAST=SDEAST+(ECORD(N)-EBAR)**2*CCR(1,N)
  640 CONTINUE
      SDNRTH=SQRT(SDNRTH/SUM)
      SDEAST=SQRT(SDEAST/SUM)
      WRITE (6,950) SUM,SUM2
      WRITE (6,960) NBAR,EBAR,SDNRTH,SDEAST
C
C     COMPUTE AND PRINT 95 PC. CONFIDENCE LIMITS OF MEAN RADIATION
C     LOCATION.
C
      RTSUM=SQRT(SUM/BGCR(1))
      CFIDN=1.96*SDNRTH/RTSUM
      CFIDE=1.96*SDEAST/RTSUM
      WRITE (6,970) CFIDN,CFIDE
  650 DO 660 I=1,2
      CCR(I,LINE+1)=BGCR(I)
  660 CCR(I,LINE+2)=SIGMA(I)
      NWRD=(LINE+2)*2
      CALL NTRAN (ITAPE,1,NWRD,CCR,L(4))
      NENTRY=3
      IF (NOPT(3).EQ.1) CALL RDPLT2 (NCORD,ECORD,CCR)
      WRITE (6,980) NMAX,EMAX
      WRITE (6,990) NMIN,EMIN
C
C     WRITE OUT THE NUMBER, COORDINATES AND ACTIVITY OF EACH DATA POINT
C
      KOUNT=50
      DO 720 N=1,LINE
      DO 690 J=1,3
      IF (FLD(36-J,1,IERR(N))) 670,670,680
  670 ISIGN(J)=BLANK
      GO TO 690
  680 ISIGN(J)=AS
  690 CONTINUE
      IF (KOUNT-50) 710,700,700
  700 WRITE (6,1000) LEGEND
      KOUNT=0
  710 WRITE (6,1010) NMBR(N),TIME(N),D(1,N),ISIGN(1),D(2,N),ISIGN(2),(RA
     1D(I,N),I=1,2),NORTH(N),EAST(N),ISIGN(3),NCORD(N),ECORD(N),(CCR(I,N
     2),I=1,2)
  720 KOUNT=KOUNT+1
      WRITE (6,1020)
      IF (.NOT.JOBEND) GO TO 10
  730 CONTINUE
C
C     END-FILE PLOT TAPE
C
      END FILE 9
      DO 760 I=1,4
  740 IF (L(I).NE.-1) GO TO 750
      GO TO 740
  750 IF (L(I).LT.-1) GO TO 770
  760 CONTINUE
      CALL NTRAN (ITAPE,9)
  770 STOP
C
  780 FORMAT (3F3.0,2F7.0,1X,2F2.0,F3.0,F5.2,3F2.0,4(1X,F7.0),I3)
  790 FORMAT (4I1,F10.0,1X,3I2,1X,F10.0,2(1X,F10.0),1X,A6)
  800 FORMAT (13A6,L2)
  810 FORMAT (10X,13A6,10X,L2)
  820 FORMAT (/5X,8HBEACON 1,F10.0,1HN,F10.0,1HE,5X,8HBEACON 2,F10.0,1HN
     1,F10.0,1HE//)
```

```
291      830   FORMAT (5X,21HSQUARE DIST BETWEEN =,E16.8,5X,18HDISTANCE BETWEEN =
              1,F10.0)
292      840   FORMAT (5X,6HSINE =,E16.8,5X,8HCOSINE =,E16.8)
293      850   FORMAT (5X,16HINJECTION TIME =,2F3.0,10X,12HCLOCK SET AT,2F3.0,5X,
              121HDIGITIZING INTERVAL =,F3.0,7HSECONDS/5X,30HDAYS ELAPSED SINCE I
              2NJECTION =,F3.0)
294      860   FORMAT (5X,22HHALF-LIFE OF ISOTOPE =,F7.2,4HDAYS,5X,14HDECAY FACTO
              1R =,E16.8,5X,19HTIME-DELAY FACTOR =,F7.2,5HHOURS)
295      870   FORMAT (10X,14HCABLE LENGTH =,F4.0,10X,18HMEAN WATER DEPTH =,F4.0,
              110X,13HBOAT LENGTH =,F4.0)
296      880   FORMAT (10X,38HDISTANCE FROM RADAR MAST TO DETECTOR =,F6.1,5HFEET.
              1)
297      890   FORMAT (//40X,15HPLOTS GENERATED/10X,9HTRACKLINE,I5,10X,20HBACKGRO
              1UND RADIATION,I5,10X,19HCORRECTED RADIATION,I5)
298      900   FORMAT (5X,51HBEACON RANGES FOR DUMP SITE COMPUTE IMAGINARY ROOT.)
299      910   FORMAT (10X,37HLAMBERT COORDINATES OF INJECTION SITE,F10.0,1HN,F10
              1.0,1HE)
300      920   FORMAT (1H0,19X,7A6)
301      930   FORMAT (37H THERE WAS AN OVERFLOW WHEN ALPHA WAS,F6.3,5X,25HCHVR W
              1AS SET EQUAL TO 5.0)
302      940   FORMAT (//20X,53HSUMMARY STATISTICS OF BACKGROUND RADIATION COUNT
              1RATE/30X,13HRAD CHANNEL 1,5X,13HRAD CHANNEL 2/10X,21HEST. BKG. COU
              2NTS/SEC.,F10.0,8X,F10.0/10X,21HMEAN BKG. COUNTS/SEC.,F10.0,8X,F10.
              30/10X,21HSTD. DEV. COUNTS/SEC.,F10.0,8X,F10.0)
303      950   FORMAT (//20X,33HSUM OF CORRECTED RADIATION COUNTS/25X,19HRADIATIO
              1N CHANNEL 1,E16.8/25X,19HRADIATION CHANNEL 2,E16.8)
304      960   FORMAT (//20X,41HSUMMARY STATISTICS OF RADIATION LOCATION./24X,11H
              1NORTH COORD,10X,10HEAST COORD/16X,4HMEAN,5X,F10.0,10X,F10.0/11X,9H
              2STD. DEV.,5X,F10.0,10X,F10.0)
305      970   FORMAT (10X,10HCONFIDENCE/7X,13HLIMIT OF MEAN,5X,F10.0,10X,F10.0)
306      980   FORMAT (//7X,13HMAXIMUM COORD,5X,F10.0,1HN,9X,F10.0,1HE)
307      990   FORMAT (//7X,13HMINIMUM COORD,5X,F10.0,1HN,9X,F10.0,1HE//)
308      1000  FORMAT (1H1,9X,13A6//2X,10HLINE  TIME,5X,18HDISTANCE TO BEACON,5X,
              115HRADIATION COUNT,4X,16HBOAT COORDINATES,4X,16HBALL COORDINATES,3
              22X,19HCORRECTED RADIATION/9X,3HSEC,11X,1H1,10X,1H2,6X,4HRAD1,6X,4HR
              3AD2,9X,1HN,9X,1HE,9X,1HN,9X,1HE,7X,4HRAD1,3X,9H     RAD2)
309      1010  FORMAT (1X,I5,F6.0,F11.1,A1,F10.1,A1,4F10.0,A1,2F10.0,F11.0,F11.0)
310      1020  FORMAT (1H1)
311            END
```

```
10     -    7*     8      276
20     -    7      9*
30     -    13     14*
40     -    12     13     15*
50     -    35     36*
60     -    40     41*
70     -    40     44*
80     -    35     43     48*    52
90     -    50     53*
100    -    54*    55
110    -    54     56*
120    -    64     65*
130    -    61     64     66*
140    -    72     74*
150    -    69     75*
160    -    67     77*
170    -    80     81*
180    -    83     84*
190    -    82     86*
200    -    79     80     83     87*
210    -    89     90*
220    -    92     93*
230    -    91     92     95*
240    -    94     96*
250    -    99*    101
260    -    88     89     101    102*
270    -    76     103*
280    -    110    111*
290    -    110    114*
300    -    105    113    117*
310    -    120*   159
320    -    122    123*
330    -    122    125*
340    -    127    129*
350    -    121    124    133*
360    -    116    119    135    136*
365    -    143*
```

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 370 | - | 142 | 145* | | | | | | | |
| 380 | - | 151 | 152* | | | | | | | |
| 390 | - | 152 | 153* | | | | | | | |
| 400 | - | 153 | 154* | | | | | | | |
| 410 | - | 151 | 152 | 153 | 154 | 155* | | | | |
| 420 | - | 150 | 154 | 157* | | | | | | |
| 430 | - | 135 | 158 | 160* | | | | | | |
| 440 | - | 163* | 164 | | | | | | | |
| 450 | - | 163 | 165* | | | | | | | |
| 460 | - | 173 | 174* | | | | | | | |
| 470 | - | 173 | 177* | | | | | | | |
| 480 | - | 171 | 176 | 179* | | | | | | |
| 490 | - | 181* | 182 | | | | | | | |
| 500 | - | 181 | 183* | | | | | | | |
| 505 | - | 184 | 185* | | | | | | | |
| 510 | - | 187 | 188 | 189* | | | | | | |
| 515 | - | 195* | | | | | | | | |
| 520 | - | 194 | 197* | | | | | | | |
| 530 | - | 204 | 205* | | | | | | | |
| 540 | - | 205 | 206* | | | | | | | |
| 550 | - | 203 | 204 | 205 | 208* | | | | | |
| 560 | - | 211 | 212* | | | | | | | |
| 570 | - | 212 | 213* | | | | | | | |
| 580 | - | 210 | 211 | 212 | 214* | | | | | |
| 590 | - | 197 | 215* | | | | | | | |
| 600 | - | 227 | 228* | | | | | | | |
| 610 | - | 225 | 227 | 229* | | | | | | |
| 620 | - | 224 | 230 | 235* | | | | | | |
| 630 | - | 241 | 242* | | | | | | | |
| 640 | - | 240 | 241 | 244* | | | | | | |
| 650 | - | 184 | 219 | 253* | | | | | | |
| 660 | - | 253 | 255* | | | | | | | |
| 670 | - | 265 | 266* | | | | | | | |
| 680 | - | 265 | 268* | | | | | | | |
| 690 | - | 264 | 267 | 269* | | | | | | |
| 700 | - | 270 | 271* | | | | | | | |
| 710 | - | 270 | 273* | | | | | | | |
| 720 | - | 263 | 274* | | | | | | | |
| 730 | - | 49 | 277* | | | | | | | |
| 740 | - | 280* | 281 | | | | | | | |
| 750 | - | 280 | 282* | | | | | | | |
| 760 | - | 270 | 283* | | | | | | | |
| 770 | - | 9 | 56 | 165 | 183 | 282 | 285* | | | |
| 780 | - | 10RD | 286* | | | | | | | |
| 790 | - | 11RD | 287* | | | | | | | |
| 800 | - | 16RD | 288* | | | | | | | |
| 810 | - | 17WR | 289* | | | | | | | |
| 820 | - | 18WR | 290* | | | | | | | |
| 830 | - | 21WR | 291* | | | | | | | |
| 840 | - | 24WR | 292* | | | | | | | |
| 850 | - | 25WR | 293* | | | | | | | |
| 860 | - | 30WR | 294* | | | | | | | |
| [illegible] | - | 31WR | 295* | | | | | | | |
| [illegible] | - | 33WR | 296* | | | | | | | |
| .0 | | 34WR | 297* | | | | | | | |
| 9 0 | - | 42WR | 298* | | | | | | | |
| 910 | - | 47WR | 299* | | | | | | | |
| 920 | - | 53WR | 300* | | | | | | | |
| 930 | - | 144WR | 196WR | 301* | | | | | | |
| 940 | - | 216WR | 302* | | | | | | | |
| 950 | - | 247WR | 303* | | | | | | | |
| 960 | - | 248WR | 304* | | | | | | | |
| 970 | - | 252WR | 305* | | | | | | | |
| 980 | - | 260WR | 306* | | | | | | | |
| 990 | - | 261WR | 307* | | | | | | | |
| 1000 | - | 271WR | 308* | | | | | | | |
| 1010 | - | 273WR | 309* | | | | | | | |
| 1020 | - | 275WR | 310* | | | | | | | |
| ABS | - | 83 | | | | | | | | |
| ALOG | - | 29 | | | | | | | | |
| ALPHA | - | 140= | 141 | 144WR | 192= | 193 | 196WR | | | |
| AS | - | 4IN | 6DA | 268 | | | | | | |
| BEAC1E | - | 1CO | 10RD | 18WR | 19 | 23 | 45 | 115 | | |
| BEAC1N | - | 1CO | 10RD | 18WR | 19 | 22 | 46 | 116 | | |
| BEAC2E | - | 1CO | 10RD | 18WR | 19 | 23 | | | | |
| BEAC2N | - | 1CO | 10RD | 18WR | 19 | 22 | | | | |
| BENLH2 | - | 162 | | | | | | | | |
| BGCR | - | 1CO | 198= | 207= | 209= | 213 | 216WR | 226 | 249 | 254 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BKG | - | 3DI | 10RD | 184 | 190 | 191 | 201 | 202 | 216WR | | |
| BLANK | - | 4IN | 6DA | 266 | | | | | | | |
| BOAT | - | 10RD | 31WR | 32 | | | | | | | |
| CABLE | - | 10RD | 31WR | 32= | 33WR | 169 | 170 | 173 | 174 | 175 | |
| CCR | - | 3DI | 185= | 186= | 189= | 190 | 191 | 204 | 205 | 207 | 211 |
| | | 212 | 213 | 218AG | 226= | 227 | 228= | 230 | 231 | 232 | 233 |
| | | 234 | 241 | 242 | 243 | 254= | 255= | 257AG | 259AG | 273WR | |
| CFIDE | - | 251= | 252WR | | | | | | | | |
| CFIDN | - | 250= | 252WR | | | | | | | | |
| CHVR | - | 141= | 143= | 145 | 146 | 147 | 148 | 193= | 195= | 201 | 202 |
| COR1 | - | 6DA | 36 | 106 | | | | | | | |
| COR2 | - | 6DA | 37 | 107 | | | | | | | |
| COSINE | - | 23= | 24WR | 45 | 46 | 115 | 116 | | | | |
| D | - | 3DI | 58RD | 73= | 80 | 83 | 84= | 89 | 92 | 97 | 99= |
| | | 106 | 107 | 128= | 273WR | | | | | | |
| DAYS | - | 10RD | 25WR | 28 | | | | | | | |
| DD1 | - | 97= | 99 | | | | | | | | |
| DEO | - | 167= | 168 | 170 | | | | | | | |
| DECAY | - | 29= | 30WR | 228 | | | | | | | |
| DELAY | - | 28= | 30WR | 228 | | | | | | | |
| DENOM | - | 168= | 169 | 170 | 172= | 173 | 174 | 175 | | | |
| DEPTH | - | 10RD | 31WR | 32 | | | | | | | |
| DFT1 | - | 106= | 108 | 109 | | | | | | | |
| DFT2 | - | 107= | 108 | | | | | | | | |
| DISTB | - | 20= | 21WR | 22 | 23 | 38 | 108 | | | | |
| DNO | - | 166= | 168 | 169 | | | | | | | |
| DTIME | - | 96= | 99 | | | | | | | | |
| DUMP1 | - | 11RD | 35 | 36= | 38 | 39 | | | | | |
| DUMP2 | - | 11RD | 37= | 38 | | | | | | | |
| DX1 | - | 38= | 39 | 45 | 46 | 108= | 109 | 115 | 116 | | |
| DY1 | - | 39= | 40 | 44= | 45 | 46 | 109= | 110 | 114= | 115 | 116 |
| EAST | - | 3DI | 115= | 130= | 139AG | 151 | 152 | 162AG | 167 | 168 | 170 |
| | | 172 | 175 | 273WR | | | | | | | |
| EBAR | - | 1CO | 138= | 139AG | 145 | 146 | 223= | 233= | 237= | 243 | 248WR |
| ECORD | - | 3DI | 170= | 172 | 175= | 178= | 180AG | 218AG | 233 | 237 | 243 |
| | | 259AG | 273WR | | | | | | | | |
| EMAX | - | 1CO | 260WR | | | | | | | | |
| EMIN | - | 1CO | 261WR | | | | | | | | |
| EXP | - | 228 | | | | | | | | | |
| FATH | - | 3DI | 58RD | 75= | | | | | | | |
| FLD | - | 265 | | | | | | | | | |
| FLOAT | - | 140 | 192 | 209 | 215 | | | | | | |
| GATE1 | - | 145= | 151 | 201= | 204 | 211 | | | | | |
| GATE2 | - | 146= | 152 | 202= | 205 | 212 | | | | | |
| GATEN1 | - | 147= | 153 | | | | | | | | |
| GATEN2 | - | 148= | 154 | | | | | | | | |
| GRID | - | 1CO | 11RD | | | | | | | | |
| HLIFE | - | 10RD | 29 | 30WR | | | | | | | |
| I | - | 11RD | 12 | 13 | 14 | 34WR | 72 | 73 | 74 | 78 | 80 |
| | | 83 | 84 | 85 | 89 | 92 | 97 | 99 | 127 | 128 | 129 |
| | | 186 | 189 | 197 | 198 | 199 | 201 | 202 | 204 | 205 | 207 |
| | | 209 | 211 | 212 | 213 | 215 | 225 | 226 | 227 | 228 | 253 |
| | | 254 | 255 | 273WR | 279 | 280 | 282 | | | | |
| IERR | - | 3DI | 60= | 62= | 85= | 111= | 122 | 132= | 155= | 265 | |
| INDATE | - | 1CO | 11RD | | | | | | | | |
| ISIGN | - | 3DI | 266= | 268= | 273WR | | | | | | |
| ISKIP | - | 10RD | 67 | 68 | 70 | 71 | 73 | 74 | 75 | 76 | |
| ITAPE | - | 6DA | 57AG | 161AG | 180AG | 257AG | 284AG | | | | |
| J | - | 264 | 266 | 268 | | | | | | | |
| JOBEND | - | 5LG | 16RD | 17WR | 276 | | | | | | |
| KEY | - | 119= | 135 | 158= | | | | | | | |
| KOUNT | - | 262= | 270 | 272= | 274= | | | | | | |
| L | - | 3DI | 7 | 9 | 54 | 56 | 57AG | 161AG | 163 | 165 | 180AG |
| | | 181 | 183 | 257AG | 280 | 282 | | | | | |
| LAG | - | 104= | 112= | 118 | 120= | 123= | 125 | 126 | 128 | 129 | 130 |
| | | 131 | 132 | 134 | 149= | 156= | 159 | 180AG | | | |
| LEGEND | - | 1CO | 16RD | 17WR | 50 | 57AG | 271WR | | | | |
| LINE | - | 1CO | 58RD | 61 | 69 | 76= | 77 | 82 | 91 | 105 | 121 |
| | | 134= | 137AG | 139AG | 150 | 161AG | 171 | 180AG | 187 | 203 | 210 |
| | | 224 | 240 | 254 | 255 | 256 | 263 | | | | |
| M | - | 79 | 80 | 81 | 83 | 88 | 89 | 90 | | | |
| MSTOP | - | 77= | 79 | 88 | | | | | | | |
| N | - | 58RD | 61 | 62 | 63 | 64 | 65 | 69 | 70 | 71 | 73 |
| | | 74 | 75 | 82 | 83 | 84 | 85 | 91 | 92 | 93 | 98= |
| | | 99 | 100= | 101 | 105 | 106 | 107 | 111 | 115 | 116 | 121 |
| | | 122 | 125 | 126 | 128 | 129 | 130 | 131 | 132 | 150 | 151 |
| | | 152 | 153 | 154 | 155 | 171 | 172 | 174 | 175 | 177 | 178 |
| | | 187 | 189 | 203 | 204 | 205 | 207 | 210 | 211 | 212 | 213 |
| | | 224 | 226 | 227 | 228 | 230 | 231 | 232 | 233 | 234 | 240 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 241 | 242 | 243 | 263 | 265 | 273WR | | | | |
| NBAR | - | 1CO | 2RL | 136= | 137AG | 147 | 148 | 222= | 234= | 236= | 242 |
| | | 248WR | | | | | | | | | |
| NCORD | - | 2RL | 169= | 172 | 174= | 177= | 180AG | 218AG | 234 | 236 | 242 |
| | | 259AG | 273WR | | | | | | | | |
| NCOUNT | - | 200= | 206= | 209 | 215 | | | | | | |
| NENTRY | - | 1CO | 160= | 217= | 258= | | | | | | |
| NMAX | - | 1CO | 2RL | 260WR | | | | | | | |
| NMBR | - | 3DI | 58RD | 63 | 70= | 125= | 161AG | 162AG | 273WR | | |
| NMIN | - | 1CO | 2RL | 261WR | | | | | | | |
| NOPT | - | 1CO | 11RD | 34WR | 162 | 218 | 219 | 259 | | | |
| NORTH | - | 2RL | 116= | 131= | 137AG | 153 | 154 | 162AG | 166 | 168 | 169 |
| | | 172 | 174 | 273WR | | | | | | | |
| NPLT | - | 1CO | 11RD | 13 | 14= | | | | | | |
| NSTART | - | 68= | 69 | 81= | 82 | 90= | 91 | 96 | 97 | 98 | 99 |
| NSTOP | - | 93= | 96 | 97 | 101 | | | | | | |
| NTAPE | - | 6DA | 48RD | 51AG | 58RD | 59AG | | | | | |
| NTRAN | - | 51 | 57 | 59 | 161 | 180 | 257 | 284 | | | |
| NWRD | - | 256= | 257AG | | | | | | | | |
| RAD | - | 3DI | 58RD | 74= | 129= | 185 | 186 | 189 | 273WR | | |
| RDPLT2 | - | 218 | 259 | | | | | | | | |
| RMIN | - | 10RD | 25WR | 27 | | | | | | | |
| RTSUM | - | 249= | 250 | 251 | | | | | | | |
| SCALE | - | 1CO | 11RD | | | | | | | | |
| SDEAST | - | 139AG | 145 | 146 | 239= | 243= | 246= | 248WR | 251 | | |
| SDNRTH | - | 137AG | 147 | 148 | 238= | 242= | 245= | 248WR | 250 | | |
| SEC | - | 10RD | 25WR | 65 | 185 | 186 | 189 | 201 | 202 | | |
| SENTNL | - | 4IN | 48RD | 49 | 50 | 53WR | | | | | |
| SETIME | - | 10RD | 25WR | 27= | 28 | | | | | | |
| SIGMA | - | 1CO | 199= | 213= | 215= | 216WR | 227 | 228 | 255 | | |
| SINE | - | 22= | 24WR | 45 | 46 | 115 | 116 | | | | |
| SITEE | - | 1CO | 45= | 47WR | | | | | | | |
| SITEN | - | 1CO | 41= | 46= | 47WR | | | | | | |
| SQDSTB | - | 19= | 20 | 21WR | 38 | 108 | | | | | |
| SQRT | - | 20 | 32 | 44 | 114 | 168 | 172 | 201 | 202 | 215 | 245 |
| | | 246 | 249 | | | | | | | | |
| STDEV | - | 137 | 139 | | | | | | | | |
| STOP | - | 285 | | | | | | | | | |
| SUM | - | 220= | 231= | 236 | 237 | 245 | 246 | 247WR | 249 | | |
| SUM2 | - | 221= | 232= | 247WR | | | | | | | |
| TIME | - | 3DI | 58RD | 64 | 65= | 71= | 83 | 96 | 99 | 126= | 228 |
| | | 273WR | | | | | | | | | |
| TINORM | - | 141 | 193 | | | | | | | | |
| WORD1 | - | 4IN | 6DA | 49 | | | | | | | |
| WORD2 | - | 4IN | 6DA | 49 | | | | | | | |
| ZHR | - | 10RD | 25WR | 26= | 28 | | | | | | |
| ZMIN | - | 10RD | 25WR | 26 | | | | | | | |

I N D E X

SUBROUTINE BENLH2 (NORTH,EAST,NMBR)

```
 1             SUBROUTINE BENLH2 (NORTH,EAST,NMBR)
         C
         C     THIS SUBROUTINE GENERATES THE PLOT INSTRUCTIONS TO DRIVE A BENSON-
         C     LEHNER MODEL 305 DIGITAL PLOTTER.  IF THE INSTRUCTIONS ARE BEING
         C     WRITTEN ON TAPE, USE OPTIONS N, K, AND E ON THE ASSIGN CARD.
         C        PROGRAMMER: PHILIP A. TURNER, GEOLOGY BR, U S A CERC
         C
 2             COMMON NOPT(4),SCALE,NPLT(3),GRID,DUMPN,DUMPE,INDATE,LEGEND(13),BE
              1AC1N,BEAC1E,BEAC2N,BEAC2E,NPTS,BGCR(2),SIGMA(2),NBAR,EBAR,NENTRY,N
              2MAX,NMIN,EMAX,EMIN
 3             DIMENSION EAST(2200), RAD(2,2200), NMBR(2200), X(2200), Y(2200), R
              1ADUL(7)
 4             REAL NORTH(2200),NBAR,NMAX,NMIN,NORGIN
 5             ITRNP=0
 6             GO TO 10
 7             ENTRY RDPLT2 (NORTH,EAST,RAD)
 8             IF (NOPT(1).EQ.1) GO TO 120
 9             IF (NOPT(2).EQ.1.AND.NENTRY.EQ.3) GO TO 120
         C     DEFINE THE LOGICAL UNIT ON WHICH PLOTTER COMMANDS ARE TO BE OUTPUT
         C           CARD PUNCH = 3
         C        MAGNETIC TAPES = 7-34
         C
 10      10    CALL INPLOT (9)
         C
         C     DETERMINE THE MAXIMUM AND MINIMUM VALUES FOR BOTH COORDINATES.
         C
```

```
      NMAX=NORTH(1)
      NMIN=NORTH(1)
      EMAX=EAST(1)
      EMIN=EAST(1)
      DO 20 N=2,NPTS
      NMAX=AMAX1(NMAX,NORTH(N))
      NMIN=AMIN1(NMIN,NORTH(N))
      EMAX=AMAX1(EMAX,EAST(N))
      EMIN=AMIN1(EMIN,EAST(N))
   20 CONTINUE
C
C     CHECK SCALE TO BE SURE THAT NO FIXES WILL PLOT OFF THE MAP.
C     CHANGE SCALE UNTIL ALL THE FIXES FIT ON THE PLOT.
C
      YSCALE=SCALE
      IF (NMAX-(NMIN+25.*SCALE)) 60,60,30
   30 ITRNP=1
      IF (EMAX-(EMIN+25.*SCALE)) 60,60,40
   40 IF ((EMAX-EMIN)-(NMAX-NMIN)) 60,50,50
   50 ITRNP=0
   60 IF (ITRNP.EQ.0) GO TO 90
      ASSIGN 90 TO KEY
   70 CELL=EMAX
      EMAX=NMAX
      NMAX=-EMIN
      EMIN=NMIN
      NMIN=-CELL
      DO 80 N=1,NPTS
      CELL=NORTH(N)
      NORTH(N)=-EAST(N)
   80 EAST(N)=CELL
      GO TO KEY, (90,130)
   90 IF (NMAX-(NMIN+25.*SCALE)) 110,110,100
  100 SCALE=SCALE+YSCALE
      GO TO 90
C
C     TAKE THE ORIGIN OF THE PLOT AS THE MINIMUM COORDINATES REMAINDERED
C     BY THE PLOT SCALE.
C
  110 NORGIN=SCALE*AINT(NMIN/SCALE)
      YORGIN=NORGIN/SCALE
      EORGIN=SCALE*AINT(EMIN/SCALE)
      XORGIN=EORGIN/SCALE
  120 IF (NENTRY.EQ.3.AND.NOPT(2).EQ.1) GO TO 150
C
C     DIVIDE THE COORDINATES (IN FEET)  BY THE SCALE (IN FEET).
C
      IF (NENTRY.EQ.1.OR.ITRNP.EQ.0) GO TO 130
      ASSIGN 130 TO KEY
      GO TO 70
  130 DO 140 N=1,NPTS
      X(N)=EAST(N)/SCALE
  140 Y(N)=NORTH(N)/SCALE
C
C     WRITE IN THE LEGEND, SCALE, TYPE OF PLOT AN INJECTION DATE AT THE
C     BOTTOM EDGE OF THE PLOT.
C
  150 CALL LETTER (78,8,0,1.0,-1.0,LEGEND)
      CALL LETTER (8,8,0,5.0,-2.2,8H1 INCH =)
      CALL NUMBER (SCALE,4,1,8,0,7.2,-2.2)
      CALL LETTER (4,8,0,9.8,-2.2,4HFEET)
      GO TO (160,170,180), NENTRY
  160 CALL LETTER (25,8,0,12.,-2.2,25HPLOT OF SURVEY TRACK LINE)
      GO TO 190
  170 CALL LETTER (29,6,0,12.,-2.0,29HPLOT OF UNCORRECTED RADIATION)
      CALL LETTER (29,6,0,12.,-2.6,29HROUNDED TO NEAREST 100 COUNTS)
      GO TO 190
  180 CALL LETTER (28,6,0,12.,-2.0,28HPLOT OF CORRECTED RADIATION/)
      CALL LETTER (27,6,0,12.,-2.6,27HBACKGROUND RADIATION RATIOS)
  190 CALL LETTER (14,6,0,20.,-2.0,14HINJECTION DATE)
      CALL LETTER (6,6,0,21.8,-2.5,INDATE)
      CALL PLOT (0.0,0.0,3)
      CALL PLOT (XORGIN,YORGIN,1)
C
```

```
      C       PLOT IN TIC MARKS, WITH COORDINATES, AT THE LEFT AND LOWER BORDERSB-L 100
      C       OF THE PLOT.                                                      B-L 101
      C                                                                         B-L 102
              CALL SYMBOL (XORGIN,YORGIN,20,66)                                 B-L 103
              IF (GRID.LE.0.0) GO TO 230                                        B-L 104
              TICN=GRID*(1.+AINT(NORGIN/GRID))                                  B-L 105
              TICE=GRID*(1.+AINT(EORGIN/GRID))                                  B-L 106
              YTIC=TICN/SCALE                                                   B-L 107
              XSHIFT=XORGIN-1.28                                                B-L 108
      200     CALL REPSYM (XORGIN,YTIC)                                         B-L 109
              CALL NUMBER (TICN,8,0,4,0,XSHIFT,YTIC)                            B-L 110
              YTIC=YTIC+GRID/SCALE                                              B-L 111
              TICN=TICN+GRID                                                    B-L 112
              IF (YTIC-(YORGIN+25.)) 200,200,210                                B-L 113
      210     XTIC=TICE/SCALE                                                   B-L 114
              YSHIFT=YORGIN-.5                                                  B-L 115
      220     CALL REPSYM (XTIC,YORGIN)                                         B-L 116
              CALL NUMBER (TICE,8,0,4,0,XTIC,YSHIFT)                            B-L 117
              XTIC=XTIC+GRID/SCALE                                              B-L 118
              TICE=TICE+GRID                                                    B-L 119
              IF (XTIC-(XORGIN+25.)) 220,220,230                                B-L 120
      230     CONTINUE                                                          B-L 121
      C                                                                         B-L 122
      C       PLOT  THE INJECTION SITE.                                         B-L 123
      C                                                                         B-L 124
              IF (DUMPN.GT.NMAX.OR.DUMPN.LT.NMIN) GO TO 240                     B-L 125
              YD=DUMPN/SCALE                                                    B-L 126
              XD=DUMPE/SCALE                                                    B-L 127
              CALL SYMBOL (XD,YD,10,70)                                         B-L 128
              XD=XD+.2                                                          B-L 129
              CALL LETTER (4,4,0,XD,YD,4HDUMP)                                  B-L 130
      C                                                                         B-L 131
      C       PLOT THE MEAN LOCATION OF THE RADIATION DISTRIBUTION.             B-L 132
      C                                                                         B-L 133
      240     IF (NENTRY-3) 260,250,260                                         B-L 134
      250     IF (ITRNP.EQ.1) GO TO 260                                         B-L 135
              YB=NBAR/SCALE                                                     B-L 136
              XB=EBAR/SCALE                                                     B-L 137
              CALL SYMBOL (XB,YB,10,71)                                         B-L 138
              XB=XB+.2                                                          B-L 139
              CALL LETTER (6,4,0,XB,YB,6HRADBAR)                                B-L 140
      260     NN=NPLT(NENTRY)                                                   B-L 141
              NSTART=1+NN                                                       B-L 142
              IF (NENTRY-2) 270,290,310                                         B-L 143
      C                                                                         B-L 144
      C       PLOT THE TRACK LINE FOLLOWED BY THE SURVEY VESSEL.                B-L 145
      C                                                                         B-L 146
      270     CALL LINE (X,Y,NPTS,3,65,5)                                       B-L 147
              DO 280 N=1,NPTS,NN                                                B-L 148
              Z=FLOAT(NMBR(N))                                                  B-L 149
              CALL NUMBER (Z,3,0,2,0,X(N),Y(N))                                 B-L 150
      280     CONTINUE                                                          B-L 151
              GO TO 440                                                         B-L 152
      C                                                                         B-L 153
      C       PLOT THE BACKGROUND RADIATION AT EVERY NNTH POINT.                B-L 154
      C                                                                         B-L 155
      290     CALL SYMBOL (X(1),Y(1),3,67)                                      B-L 156
              Z=RAD(1,1)/100.                                                   B-L 157
              CALL NUMBER (Z,3,0,2,0,X(1),Y(1))                                 B-L 158
              DO 300 I=NSTART,NPTS                                              B-L 159
              CALL REPSYM (X(I),Y(I))                                           B-L 160
              IF (MOD(I,NN).NE.0) GO TO 300                                     B-L 161
              Z=RAD(1,I)/100.                                                   B-L 162
              CALL NUMBER (Z,3,0,2,0,X(I),Y(I))                                 B-L 163
      300     CONTINUE                                                          B-L 164
              GO TO 440                                                         B-L 165
      C                                                                         B-L 166
      C       PLOT CORRECTED RADIATION VALUES AT EVERY NNTH POINT.              B-L 167
      C                                                                         B-L 168
      310     RADUL(1)=3.*SIGMA(1)                                              B-L 169
              RADUL(2)=100.                                                     B-L 170
              DO 320 L=3,7                                                      B-L 171
      320     RADUL(L)=2.*RADUL(L-1)                                            B-L 172
              LAST=0                                                            B-L 173
              DO 420 I=1,NPTS                                                   B-L 174
      C                                                                         B-L 175
```

```
      C     DATA POINTS HAVING CORRECTED RADIATION COUNTS MORE THAN 3 STANDARDB-L 176
      C     DEVIATIONS BELOW MEAN BACKGROUND COUNT RATE ARE NOT PLOTTED.  SUCHB-L 177
      C     LOW READINGS MAY INDICATE THAT THE DETECTOR WAS OVERTURNED OR WAS B-L 178
      C     'FLYING'                                                          B-L 179
      C                                                                       B-L 180
            IF (RAD(1,I)+RADUL(1)) 420,420,330                                B-L 181
      330   DO 350 L=1,7                                                      B-L 182
            IF (RAD(1,I)-RADUL(L)) 340,340,350                                B-L 183
      340   NSYM=64+L                                                         B-L 184
            IH=1                                                              B-L 185
            IF (NSYM.GT.65) IH=2                                              B-L 186
            IF (NSYM.GT.69) IH=4                                              B-L 187
            GO TO 360                                                         B-L 188
      350   CONTINUE                                                          B-L 189
            NSYM=72                                                           B-L 190
            IH=4                                                              B-L 191
      360   IF (NSYM-LAST) 380,370,380                                        B-L 192
      370   CALL REPSYM (X(I),Y(I))                                           B-L 193
            GO TO 390                                                         B-L 194
      380   CALL SYMBOL (X(I),Y(I),IH,NSYM)                                   B-L 195
            LAST=NSYM                                                         B-L 196
      390   IF (MOD(I,NN)) 400,400,420                                        B-L 197
      400   IF (RAD(1,I)-BGCR(1)) 420,420,410                                 B-L 198
      410   Z=RAD(1,I)/BGCR(1)                                                B-L 199
            CALL NUMBER (Z,3,0,2,0,X(I),Y(I))                                 B-L 200
      420   CONTINUE                                                          B-L 201
            XEDGE=AMAX1((EMAX/SCALE)+2.,XORGIN+27)                            B-L 202
            YPT=YORGIN+12.5                                                   B-L 203
            CALL LETTER (26,4,0,XEDGE,YPT,26HCORRECTED COUNT RATE (C/S))      B-L 204
            YPT=YPT-.5                                                        B-L 205
            XSHIFT=XEDGE+.5                                                   B-L 206
            XSHFT2=XSHIFT+2.0                                                 B-L 207
            NSYM=64                                                           B-L 208
            IH=1                                                              B-L 209
            DO 430 L=1,7                                                      B-L 210
            NSYM=NSYM+1                                                       B-L 211
            IF (NSYM.GT.65) IH=2                                              B-L 212
            IF (NSYM.GT.69) IH=4                                              B-L 213
            CALL SYMBOL (XEDGE,YPT,IH,NSYM)                                   B-L 214
            CALL LETTER (16,3,0,XSHIFT,YPT,16HCCR .LT. OR .EQ.)               B-L 215
            CALL NUMBER (RADUL(L),5,1,3,0,XSHFT2,YPT)                         B-L 216
      430   YPT=YPT-.4                                                        B-L 217
            CALL SYMBOL (XEDGE,YPT,IH,72)                                     B-L 218
            CALL LETTER (16,3,0,XSHIFT,YPT,16H        CCR .GT.)               B-L 219
            CALL NUMBER (RADUL(7),5,1,3,0,XSHFT2,YPT)                         B-L 220
      C                                                                       B-L 221
      C     MOVE PEN TO RIGHT BORDER OF PLOT IN PREPARATION FOR NEXT PLOT.    B-L 222
      C                                                                       B-L 223
      440   XEDGE=AMAX1(EMAX/SCALE+9.,XORGIN+34.)                             B-L 224
            CALL PLOT (XEDGE,YORGIN,3)                                        B-L 225
            CALL PLOT (0.0,0.0,1)                                             B-L 226
            CALL PLOT (0.0,0.0,-3)                                            B-L 227
            IF (ITRNP.EQ.0) GO TO 460                                         B-L 228
            CELL=EMAX                                                         B-L 229
            EMAX=-NMIN                                                        B-L 230
            NMIN=EMIN                                                         B-L 231
            EMIN=-NMAX                                                        B-L 232
            NMAX=CELL                                                         B-L 233
            DO 450 N=1,NPTS                                                   B-L 234
            CELL=EAST(N)                                                      B-L 235
            EAST(N)=-NORTH(N)                                                 B-L 236
      450   NORTH(N)=CELL                                                     B-L 237
      460   RETURN                                                            B-L 238
            END                                                               B-L 239-
SYMBOL

10     -    6      10*
20     -    15     20*
30     -    22     23*
40     -    24     25*
50     -    25     26*
60     -    22     24     25     27*
70     -    29*    49
80     -    34     37*
90     -    27     28     38     39*    41
100    -    39     40*
110    -    39     42*
```

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 120 | - | 8 | 9 | 46* | | | | | | | |
| 130 | - | 38 | 47 | 48 | 50* | | | | | | |
| 140 | - | 50 | 52* | | | | | | | | |
| 150 | - | 46 | 53* | | | | | | | | |
| 160 | - | 57 | 58* | | | | | | | | |
| 170 | - | 57 | 60* | | | | | | | | |
| 180 | - | 57 | 63* | | | | | | | | |
| 190 | - | 59 | 62 | 65* | | | | | | | |
| 200 | - | 75* | 79 | | | | | | | | |
| 210 | - | 79 | 80* | | | | | | | | |
| 220 | - | 82* | 86 | | | | | | | | |
| 230 | - | 70 | 86 | 87* | | | | | | | |
| 240 | - | 88 | 94* | | | | | | | | |
| 250 | - | 94 | 95* | | | | | | | | |
| 260 | - | 94 | 95 | 101* | | | | | | | |
| 270 | - | 103 | 104* | | | | | | | | |
| 280 | - | 105 | 108* | | | | | | | | |
| 290 | - | 103 | 110* | | | | | | | | |
| 300 | - | 113 | 115 | 118* | | | | | | | |
| 310 | - | 103 | 120* | | | | | | | | |
| 320 | - | 122 | 123* | | | | | | | | |
| 330 | - | 126 | 127* | | | | | | | | |
| 340 | - | 128 | 129* | | | | | | | | |
| 350 | - | 127 | 128 | 134* | | | | | | | |
| 360 | - | 133 | 137* | | | | | | | | |
| 370 | - | 137 | 138* | | | | | | | | |
| 380 | - | 137 | 140* | | | | | | | | |
| 390 | - | 139 | 142* | | | | | | | | |
| 400 | - | 142 | 143* | | | | | | | | |
| 410 | - | 143 | 144* | | | | | | | | |
| 420 | - | 125 | 126 | 142 | 143 | 146* | | | | | |
| 430 | - | 155 | 162* | | | | | | | | |
| 440 | - | 109 | 119 | 166* | | | | | | | |
| 450 | - | 176 | 179* | | | | | | | | |
| 460 | - | 170 | 180* | | | | | | | | |
| AINT | - | 42 | 44 | 71 | 72 | | | | | | |
| AMAX1 | - | 16 | 18 | 147 | 166 | | | | | | |
| AMIN1 | - | 17 | 19 | | | | | | | | |
| BEAC1E | - | 2CO | | | | | | | | | |
| BEAC1N | - | 2CO | | | | | | | | | |
| BEAC2E | - | 2CO | | | | | | | | | |
| BEAC2N | - | 2CO | | | | | | | | | |
| BENLH2 | - | 1 | | | | | | | | | |
| BGCR | - | 2CO | 143 | 144 | | | | | | | |
| CELL | - | 29= | 33 | 35= | 37 | 171= | 175 | 177= | 179 | | |
| DUMPE | - | 2CO | 90 | | | | | | | | |
| DUMPN | - | 2CO | 88 | 89 | | | | | | | |
| EAST | - | 1AG | 3DI | 7 | 13 | 14 | 18 | 19 | 36 | 37= | 51 |
| | | 177 | 178= | | | | | | | | |
| EBAR | - | 2CO | 97 | | | | | | | | |
| EMAX | - | 2CO | 13= | 18= | 24 | 25 | 29 | 30= | 147 | 166 | 171 |
| | | 172= | | | | | | | | | |
| EMIN | - | 2CO | 14= | 19= | 24 | 25 | 31 | 32= | 44 | 173 | 174= |
| EORGIN | - | 44= | 45 | 72 | | | | | | | |
| FLOAT | - | 106 | | | | | | | | | |
| GRID | - | 2CO | 70 | 71 | 72 | 77 | 78 | 84 | 85 | | |
| I | - | 113 | 114AG | 115 | 116 | 125 | 126 | 128 | 138AG | 140AG | 142 |
| | | 143 | 144 | | | | | | | | |
| IH | - | 130= | 131= | 132= | 136= | 140AG | 154= | 157= | 158= | 159AG | 163AG |
| INDATE | - | 2CO | | | | | | | | | |
| INPLOT | - | 10 | | | | | | | | | |
| ITRNP | - | 5= | 23= | 26= | 27 | 47 | 95 | 170 | | | |
| KEY | - | 28= | 38 | 48= | | | | | | | |
| L | - | 122 | 123 | 127 | 128 | 129 | 155 | 161AG | | | |
| LAST | - | 124= | 137 | 141= | | | | | | | |
| LEGEND | - | 2CO | | | | | | | | | |
| LETTER | - | 53 | 54 | 56 | 58 | 60 | 61 | 63 | 64 | 65 | 66 |
| | | 93 | 100 | 149 | 160 | 164 | | | | | |
| LINE | - | 104 | | | | | | | | | |
| MOD | - | 115 | 142 | | | | | | | | |
| N | - | 15 | 16 | 17 | 18 | 19 | 34 | 35 | 36 | 37 | 50 |
| | | 51 | 52 | 105 | 106 | 176 | 177 | 178 | 179 | | |
| NBAR | - | 2CO | 4RL | 96 | | | | | | | |
| NENTRY | - | 2CO | 9 | 46 | 47 | 57 | 94 | 101 | 103 | | |
| NMAX | - | 2CO | 4RL | 11= | 16= | 22 | 25 | 30 | 31= | 39 | 88 |
| | | 174 | 175= | | | | | | | | |
| NMBR | - | 1AG | 3DI | 106 | | | | | | | |
| NMIN | - | 2CO | 4RL | 12= | 17= | 22 | 25 | 32 | 33= | 39 | 42 |

```
                 88      172      173=
NN        -     101=     102      105      115      142
NOPT      -      2CO      8        9        46
NORGIN    -      4RL     42=      43        71
NORTH     -      1AG      4RL      7        11       12       16       17       35       36=      52
                178      179=
NPLT      -      2CO     101
NPTS      -      2CO      15      34        50      104AG    105      113      125      176
NSTART    -     102=     113

NSYM      -     129=     131      132      135=     137      140AG    141      153=     156=     157
                158      159AG
NUMBER    -      55       76       83      107      112      117      145      161      165
PLOT      -      67       68      167      168      169
RAD       -      3DI      7       111      116      126      128      143      144
RADUL     -      3DI     120=     121=     123=     126      128      161AG    165AG
RDPLT2    -      7
REPSYM    -      75       82      114      138
RETURN    -     180
SCALE     -      2CO      21       22       24       39       40=      42       43       44       45
                 51       52       55AG     73       77       80       84       89       90       96
                 97      147      166
SIGMA     -      2CO     120
SYMBOL    -      69       91       98      110      140      159      163
TICE      -      72=      80       83AG     85=
TICN      -      71=      73       76AG     78=
X         -      3DI      51=     104AG    110AG    114AG    138AG    140AG
XB        -      97=      98AG     99=
XD        -      90=      91AG     92=
XEDGE     -     147=     151      159AG    163AG    166=     167AG
XORGIN    -      45=      68AG     69AG     74       75AG     86      147      166
XSHFT2    -     152=
XSHIFT    -      74=     151=     152
XTIC      -      80=      82AG     84=      86
Y         -      3DI      52=     104AG    110AG    114AG    138AG    140AG
YB        -      96=      98AG
YD        -      89=      91AG
YORGIN    -      43=      68AG     69AG     79       81       82AG    148      167AG
YPT       -     148=     150=     159AG    162=     163AG
YSCALE    -      21=      40
YSHIFT    -      81=
YTIC      -      73=      75AG     77=      79
Z         -     106=     107AG    111=     112AG    116=     117AG    144=     145AG
```

```
   1          SUBROUTINE STDEV(X,N,XND,S)                                      STDEV
        C-----------------------------------------------------------------------STDEV
        C     CALCULATES THE STANDARD DEVIATION OF A SEQUENCE OF DATA POINTS    STDEV
        C-----------------------------------------------------------------------STDEV
   2          DIMENSION X(1)                                                   STDEV
   3          ENS=XND                                                          STDEV
   4          CALL AMEAN(X,N,XND)                                              STDEV
   5          S=0.                                                             STDEV
   6          DO1 I=1,N                                                        STDEV
   7        1 S=S+(X(I)-XND)*(X(I)-XND)                                        STDEV
   8          IF(ENS .LT. 0.) GO TO 2                                          STDEV
   9          N=N-1                                                            STDEV
  10        2 S = SQRT(S/FLOAT(N))                                             STDEV
  11          RETURN                                                           STDEV
  12          END                                                              STDEV
```

```
SYMBOL     = = = = = = = = = = = = = = =     REFERENCES    = = = = = = = = = = = = = = =

1         -      6        7*
2         -      8       10*
AMEAN     -      4
ENS       -      3=       8
FLOAT     -     10
I         -      6        7
N         -      1AG      4AG      6        9=      10
RETURN    -     11
S         -      1AG      5=       7=      10=
SQRT      -     10
STDEV     -      1
X         -      1AG      2DI      4AG      7
XND       -      1AG      3        4AG      7
```

SUBROUTINE AMEAN(X,N,XBAR)

```
 1          SUBROUTINE AMEAN(X,N,XBAR)                                      AMEAN
      C-----------------------------------------------------------------------AMEAN
      C     CALCULATES THE ARITHMETIC MEAN OF A SEQUENCE OF DATA POINTS        AMEAN
      C-----------------------------------------------------------------------AMEAN
 2          DIMENSION X(1)                                                  AMEAN
 3          XBAR=0.                                                         AMEAN
 4          DO1 I=1,N                                                       AMEAN
 5        1 XBAR=XBAR+X(I)                                                  AMEAN
 6          XBAR = XBAR/FLOAT(N)                                            AMEAN
 7          RETURN                                                          AMEAN
 8          END                                                             AMEAN
```

```
SYMBOL     = = = = = = = = = = = = = = =   REFERENCES   = = = = = = = = = = = = = = =

1        -    4       5*
AMEAN    -    1
FLOAT    -    6
I        -    4       5
N        -    1AG     4       6
RETURN   -    7
X        -    1AG     2DI     5
XBAR     -    1AG     3=      5=      6=
```

```
 1          FUNCTION TINORM(ALPHA,S)                                        TINORM
 2          DIMENSION A(3),B(3)                                             TINORM
 3          DATA(A(I),I=1,3)/.010328,.802853,2.515517/,(B(I),I=1,3)/.0010308, TINORM
          1.189269,1.432788/                                                TINORM
      C-----------------------------------------------------------------------TINORM
      C     APPROXIMATION TO INVERSE NORMAL DISTRIBUTION                      TINORM
      C-----------------------------------------------------------------------TINORM
 4          IF(.NOT.(ALPHA.GT.0..AND.ALPHA.LT.1.)) GO TO 1                  TINORM
 5          X=ALPHA                                                         TINORM
 6          IF(X.GT..5) X=1.-X                                              TINORM
 7          X=SQRT(-2.*ALOG(X))                                             TINORM
 8          TINORM=X-(A(3)+X*(A(2)+X*A(1)))/(1.+X*(B(3)+X*(B(2)+X* B(1))))  TINORM
 9          CALL OVERFL(I)                                                  TINORM
10          IF(I.EQ.1) RETURN 2                                             TINORM
11          IF(ALPHA.LT..5) TINORM=-TINORM                                  TINORM
12          RETURN                                                          TINORM
13        1 RETURN 2                                                        TINORM
14          END                                                             TINORM
```

```
SYMBOL     = = = = = = = = = = = = = = =   REFERENCES   = = = = = = = = = = = = = = =

1        -    4       13*
A        -    2DI     3DA     8
ALOG     -    7
ALPHA    -    1AG     4       5       11
B        -    2DI     3DA     8
I        -    3DA     9AG     10
OVERFL   -    9
RETURN   -    10      12      13
SQRT     -    7
TINORM   -    1       8=      11=
X        -    5=      6       7=      8
```

-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

## APPENDIX B

## LISTING AND INDEX OF RAPLOT III PROGRAM

FORTRAN IV Listing of RAPLOT III and Subroutines TRACK and TINORM with an Index to all Statement Numbers, Variable Names, and Subroutine Calls

PROGRAM -- RAPLOT III MODIFIED FOR IBM-7094 WITH SC-4060 CRT

```
      C     PROGRAM -- RAPLOT III  MODIFIED FOR IBM-7094 WITH SC-4060 CRT
      C     THE PURPOSE OF THIS PROGRAM IS TO REDUCE THE RADIOACTIVITY SURVEY
      C     DATA FROM THE RIST PROJECT AND PLOT THE SURVEY ON A BENSON-LEHNER
      C     INCREMENTAL PLOTTER.  THE FOLLOWING PLOTS ARE THE OUTPUT,
      C        TRACKLINE FOLLOWED BY SURVEY VESSEL
      C        PLOT OF UNCORRECTED RADIATION VALUES (BACKGROUND SURVEY)
      C        SYMBOL PLOT OF RADIATION VALUES CORRECTED FOR BACKGROUND AND
      C                  DECAY SINCE INJECTION TIME.
      C        PROGRAMMER:  PHILIP A. TURNER
      C                     GEOLOGY BRANCH
      C                     U S ARMY COASTAL ENGINEERING RESEARCH CENTER
      C                     5201 LITTLE FALLS ROAD
      C                     WASHINGTON, D. C.   20016
      C        COMPLETED IN JANUARY  1969
      C
      C     FORMAT AND ENTRIES ON DATA CONTROL CARD
      C          COL  1- 3  CABLE LENGTH IN FEET TO THE NEAREST FOOT.
      C          COL  4- 6  WATER DEPTH PLUS FREEBOARD TO THE NEAREST FOOT.
      C          COL  7- 9  DISTANCE FROM RADAR MAST TO CABLE STANCHION IN FEET
      C                     TO THE NEAREST FOOT.
      C          COL 10-16  ESTIMATED BACKGROUND COUNT RATE IN COUNTS/SEC FOR
      C                     CHANNEL 1.
      C          COL 17-23  ESTIMATED BACKGROUND COUNT RATE IN COUNTS/SEC FOR
      C                     CHANNEL 2.
      C          COL 25-28  TIME OF INJECTION IN HOURS AND MINUTES.
      C          COL 29-31  THE NUMBER OF DAYS SINCE THE INJECTION
      C          COL 32-36  THE HALF LIFE OF THE RADIOISOTOPE IN DAYS.
      C                          THE DECIMAL POINT MUST BE PUNCHED IN.
      C          COL 37-40  THE TIME WHEN THE SURVEY WAS STARTED, IN HOURS AND
      C                          MINUTES.
      C          COL 44-50  BEACON1 NORTH COORD/ LAMBERT COORDINATES OF RADAR
      C          COL 52-58  BEACON1  EAST COORD/ BEACONS TO THE NEAREST FOOT.
      C          COL 60-66  BEACON2 NORTH COORD/ BEACON1 IS ALWAYS UPCOAST.
      C          COL 68-74  BEACON2  EAST COORD/
      C          COL 75-77  THE NUMBER OF LINES OF DATA TO BE SKIPPED AT THE
      C                         BEGINNING OF A DATA SET IN ORDER TO AVOID
      C                         READING IN SOME BAD DATA.
      C     FORMAT AND ENTRIES ON PLOT CONTROL CARD
      C          COL  1- 3  PLOT OPTION CONTROL.  TO USE, PUNCH THE NUMERAL 1
      C                     IN THE COLIMN INDICATED.
      C                     1 = PLOT TRACKLINE FOLLOWED BY SURVEY VESSEL.
      C                     2 = PLOT UNCORRECTED RADIATION VALUES.
      C                     3 = PLOT RADIATION VALUES CORRECTED FOR BACKGROUND
      C                         AND DECAY SINCE TIME ZERO.
      C                     4 = UNUSED. LEAVE BLANK.
      C          COL  5-14  MAP SCALE EXPRESSED IN UNITS PER INCH
      C          COL 16-17  OPTION 1 / USE WHEN SPOTTING DATA FOR EACH PLOT
      C          COL 18-19     ]    2 / OPTION.  USER CAN SPECIFY THAT EVERY NTH
      C          COL 20-21     ]    4 / POINT BE PLOTTED.  IF LEFT BLANK, THE
      C                                 PROGRAM ASSUMES EVERY POINT IS TO BE
      C                                 PLOTTED.
      C          COL 23-32  INTERVALS ON THE COORDINATE GRID AT WHICH TICK
      C                     MARKS WITH THE LAMBERT COORDINATES WILL BE POSTED.
      C                     IF FIELD IS LEFT BLANK, PROGRAM WILL ASSUME THAT
      C                     NO TICK MARKS ARE TO BE PLOTTED AND POSTED.
      C          COL 34-43  BEACON 1 / INJECTION SITE. DISTANCE IN METERS TO
      C          COL 45 54  BEACON 2 / THE NAMED BEACONS. IF FIELDS ARE LEFT
      C                                 BLANK, SITE IS NOT PLOTTED.
      C          COL 56-61  DAY,MONTH AND YEAR THE SAND WAS INJECTED
      C     FORMAT AND ENTRIES ON PLOT IDENTIFICATION CARD
      C          COL  1-78  THIS FIELD WILL BE PLOTTED ON THE LOWER MARGIN OF
      C                     THE MAP.
      C          COL 80     PUNCH 'T' HERE ON THE LAST DATA SET.
 1              COMMON /AA/ NOPT(4),NPLT(3),SCALE,GRID,DUMPN,DUMPE,NBAR,EBAR,LEGEN
               1D(13),INDATE,LINE,BGCR,SIGMA,NMAX,NMIN,EMAX,EMIN,JOBEND,NENTRY,NCA
               2LLS,NCAM
 2              REAL NORTH(2000),NCORD(2000),NBAR,NMAX,NMIN
 3              DIMENSION NMBR(2000), TIME(2000), D(2,2000), EAST(2000), ECORD(200
               10), RAD(2000), CCR(2000), FATH(2000)
 4              EQUIVALENCE (RAD(1),CCR(1)), (D(1,1),NCORD(1)), (D(1,1001),ECORD(1
               1)),
 5              LOGICAL JOBEND
 6              DATA CORR1,CORR2/2.9,2.8/IFLAG/1H*/
 7              WRITE (6,610)
 8              NCAM=9
 9              NCALLS=0
10       10     NCALLS=NCALLS+1
```

```
      C
      C     READ IN DATA CONTROL CARD
      C
            READ (5,620) CABLE,DEPTH,BOAT,BKG,ZHR,ZMIN,DAYS,HLIFE,SETIME,RMIN,
           1SEC,BEAC1N,BEAC1E,BEAC2N,BEAC2E,ISKIP
      C
      C     READ IN PLOT CONTROL PARAMETERS
      C
            READ (5,630) NOPT,SCALE,(NPLT(I),I=1,3),GRID,DUMP1,DUMP2,INDATE
            DO 30 I=1,3
            IF (NPLT(I)) 20,20,30
      20    NPLT(I)=1
      30    CONTINUE
      C
      C     READ IN PLOT LEGEND
      C
            READ (5,640) LEGEND,JOBEND
            WRITE (6,650) LEGEND,JOBEND
            WRITE (6,660) BEAC1N,BEAC1E,BEAC2N,BEAC2E
      C
      C     COMPUTE PROGRAM PARAMETERS FROM DATA CONTROL CARD ENTRIES
      C
            SQDSTB=(BEAC2N-BEAC1N)**2+(BEAC2E-BEAC1E)**2
            DISTB=SQRT(SQDSTB)
            WRITE (6,670) SQDSTB,DISTB
            SINE=(BEAC2N-BEAC1N)/DISTB
            COSINE=(BEAC2E-BEAC1E)/DISTB
            WRITE (6,680) SINE,COSINE
            WRITE (6,690) ZHR,ZMIN,SETIME,RMIN,SEC,DAYS
            ZHR=ZHR+ZMIN/60.
            SETIME=SETIME+RMIN/60.
            DELAY=SETIME+DAYS*24.-ZHR
            IF (HLIFE.GT.0.0) DECAY=ALOG(2.)/(HLIFE*24.)
            WRITE (6,700) HLIFE,DECAY,DELAY
            WRITE (6,710) CABLE,DEPTH,BOAT
            CABLE=BOAT+SQRT(CABLE**2-DEPTH**2)
            WRITE (6,720) CABLE
            WRITE (6,730) (NOPT(I),I=1,3)
      C
      C     COMPUTE COORDINATES OF THE INJECTION SITE FROM THE DISTANCES FROM
      C     THE BEACONS
      C
            IF (DUMP1) 70,70,40
      40    DUMP1=(DUMP1+CORR1)*3.28083
            DUMP2=(DUMP2+CORR2)*3.28083
            DX1=(SQDSTB+DUMP1*DUMP1-DUMP2*DUMP2)/(DISTB*2.)
            DY1=DUMP1*DUMP1-DX1*DX1
            IF (DY1) 50,50,60
      50    SITEN=-999999.
            WRITE (6,740)
            GO TO 70
      60    DY1=-SQRT(DY1)
            SITEE=DX1*COSINE-DY1*SINE+BEAC1E
            SITEN=DX1*SINE+DY1*COSINE+BEAC1N
            WRITE (6,750) SITEN,SITEE
      C
      C     READ IN THE DATA FILE FROM ONE RIST SURVEY, ELIMINATING ANY LINES
      C      THAT CONTAIN A -3, WHICH IS AN ERROR FLAG
      C
      70    N=1
      80    CALL RESET
            READ (5,760) NMBR(N),TIME(N),D(1,N),D(2,N),RAD(N),FATH(N),JFLAG
      C
      C     CHECK FOR END OF FILE
      C
            CALL CHECK (E)
            IF (E) 100,90,100
      C
      C     CHECK ERROR FLAG ON INPUT RECORD
      C
      90    IF (IFLAG.NE.JFLAG) GO TO 80
            IF (NMBR(N).LT.0) GO TO 80
            IF (TIME(N).LT.0.0) GO TO 80
            IF (D(1,N).LT.0.0) GO TO 80
            IF (D(2,N).LT.0.0) GO TO 80
            IF (RAD(N).LT.0.0) GO TO 80
            IF (FATH(N).LT.0.0) GO TO 80
            IF (N.GE.2000) GO TO 100
            N=N+1
            GO TO 80
```

```
  100 CONTINUE
      N=N-1
      LINE=N-1
      IF (ISKIP.LE.0) GO TO 130
C
C     SKIP LEADING CARD IMAGES THAT CONTAIN BAD DATA.
C
      NSTART=ISKIP+1
      DO 120 N=NSTART,LINE
      NN=N-ISKIP
      NMBR(NN)=NMBR(N)
      TIME(NN)=TIME(N)
      DO 110 I=1,2
  110 D(I,NN)=D(I,N)
      RAD(NN)=RAD(N)
  120 FATH(NN)=FATH(N)
      LINE=LINE-ISKIP
  130 MSTOP=LINE-1
C
C     CHECK DISTANCES TO RADAR BEACONS FOR ERRORS.  IF DISTANCE/TIME
C     FOR SUCCESSIVE BEACON RANGES INDICATE A SHIP SPEED .GT. 6 KNOTS
C     (3.09 METERS/SEC),RANGE IS IN ERROR.
C
      DO 240 I=1,2
      DO 170 M=1,MSTOP
      IF (D(I,M)) 170,170,140
  140 NSTART=M+1
      DO 160 N=NSTART,LINE
      IF (ABS(D(I,N)-D(I,M))-(TIME(N)-TIME(M))*3.08865) 170,170,150
  150 D(I,N)=-1.
  160 CONTINUE
  170 CONTINUE
      DO 230 M=1,MSTOP
      IF (D(I,M)) 180,180,230
  180 NSTART=M
C
C     CORRECT ERRONEOUS BEACON RANGES BY LINEAR INTERPOLATION (ON TIME)
C     BETWEEN NON-ERRONEOUS RANGES.
C
      DO 200 N=NSTART,LINE
      IF (D(I,N)) 200,200,190
  190 NSTOP=N
      GO TO 210
  200 CONTINUE
  210 DTIME=TIME(NSTOP)-TIME(NSTART-1)
      DD1=D(I,NSTOP)-D(I,NSTART-1)
      N=NSTART
  220 D(I,N)=D(I,NSTART-1)+DD1*(TIME(N)-TIME(NSTART-1))/DTIME
      N=N+1
      IF (N-NSTOP) 220,230,230
  230 CONTINUE
  240 CONTINUE
C
C     COMPUTE POSITION OF SHIP FROM DISTANCES FROM THE TWO BEACONS
C
      LAG=0
      DO 270 N=1,LINE
C
C     MAKE CONSTANT CORRECTION FOR CUBIC AUTOTAPE INTERROGATOR
C     AND CONVERT TO FEET
C
      DFT1=(D(1,N)+CORR1)*3.28083
      DFT2=(D(2,N)+CORR2)*3.28083
      DX1=(SQDSTB+DFT1*DFT1-DFT2*DFT2)/(2.*DISTB)
      DY1=DFT1*DFT1-DX1*DX1
C
C     CHECK FOR IMAGINARY ROOT.
C
      IF (DY1) 250,250,260
  250 NORTH(N)=-1.
      LAG=LAG+1
      GO TO 270
  260 DY1=-SQRT(DY1)
C
C     ROTATE COORDINATES AND TRANSLATE INTO CALIFORNIA LAMBERT COORDINAT
C     SYSTEM
C
      EAST(N)=DX1*COSINE-DY1*SINE+BEAC1E
      NORTH(N)=DX1*SINE+DY1*COSINE+BEAC1N
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```
  270 CONTINUE
      IF (LAG.EQ.0) GO TO 330
      ASSIGN 330 TO KEY
C
C     ELIMINATE DATA SETS FOR WHICH AN
C     IMAGIN ARY FIX WAS OBTAINED
C
  280 LAG=0
      DO 320 N=1,LINE
      IF (NORTH(N)) 290,290,300
  290 LAG=LAG+1
      GO TO 320
  300 NN=N-LAG
      NMBR(NN)=NMBR(N)
      TIME(NN)=TIME(N)
      DO 310 I=1,2
  310 D(I,NN)=D(I,N)
      RAD(NN)=RAD(N)
      EAST(NN)=EAST(N)
      NORTH(NN)=NORTH(N)
  320 CONTINUE
      LINE=LINE-LAG
      GO TO KEY, (330,400)
C
C     CHECK NORTH AND EAST COORDINATES FOR
C     EXTREME VALUES BY CHAUVENET'S CRITERION
C
  330 NBAR=-1.
      CALL STDEV (NORTH,LINE,NBAR,SDNRTH)
      EBAR=-1.
      CALL STDEV (EAST,LINE,EBAR,SDEAST)
      ALPHA=1.-1./FLOAT(2*LINE)
      CALL TINORM (CHVR,ALPHA,$335)
      GO TO 340
  335 CHVR=5.
      WRITE (6,770) ALPHA
  340 GATE1=EBAR-CHVR*SDEAST
      GATE2=EBAR+CHVR*SDEAST
      GATEN1=NBAR-CHVR*SDNRTH
      GATEN2=NBAR+CHVR*SDNRTH
      LAG=0
      DO 390 N=1,LINE
      IF (EAST(N)-GATE1) 380,350,350
  350 IF (EAST(N)-GATE2) 360,360,380
  360 IF (NORTH(N)-GATEN1) 380,370,370
  370 IF (NORTH(N)-GATEN2) 390,390,380
  380 NORTH(N)=-1.
      LAG=LAG+1
  390 CONTINUE
      ASSIGN 400 TO KEY
C
C     ELIMINATE ANY DATA SETS THAT HAVE AN EXTREME
C     VALUES OF THE NORTH OR EAST COORDINATES
C
      IF (LAG.GT.0) GO TO 280
C
C     CALL SUBROUTINE FOR PLOTTING THE TRACK OF THE SURVEY VESSEL.
C
  400 NENTRY=1
      IF (NOPT(1).EQ.1) CALL TRACK (NORTH,EAST,NMBR)
C
C     APPLY A CORRECTION TO ALLOW FOR THE DISTANCE THE DETECTOR IS TOWED
C        ASTERN OF THE SURVEY SHIP.
C
      DNO=NORTH(1)-(NORTH(2)-NORTH(1))
      DEO=EAST(1)-(EAST(2)-EAST(1))
      DENOM=SQRT((NORTH(1)-DNO)**2+(EAST(1)-DEO)**2)
      NCORD(1)=NORTH(1)-CABLE*(NORTH(1)-DNO)/DENOM
      ECORD(1)=EAST(1)-CABLE*(EAST(1)-DEO)/DENOM
      DO 430 N=2,LINE
      DENOM=SQRT((NORTH(N)-NCORD(N-1))**2+(EAST(N)-ECORD(N-1))**2)
C
C     THE CORRECTION FOR THE DISTANCE BETWEEN VESSEL AND THE DETECTOR
C     IS EQUAL TO 'CABLE' UNLESS THE VESSEL IS LESS THAN 'CABLE' FEET
C     AWAY FROM THE LAST COMPUTED POSITION OF THE DETECTOR VEHICLE.  IN
C     THIS EVENT, THE NEW COMPUTED DETECTOR POSITION IS THE SAME AS
C     THE LAST DETECTOR POSITION
C
```

```
      IF (DENOM-CABLE) 420,420,410
  410 NCORD(N)=NORTH(N)-CABLE*(NORTH(N)-NCORD(N-1))/DENOM
      ECORD(N)=EAST(N)-CABLE*(EAST(N)-ECORD(N-1))/DENOM
      GO TO 430
  420 NCORD(N)=NCORD(N-1)
      ECORD(N)=ECORD(N-1)
  430 CONTINUE
C
C     CONVERT RADIATION READINGS TO COUNTS PER SECOND
C
      CCR(1)=RAD(1)/SEC
      DO 450 N=2,LINE
      IF (NMBR(N).NE.NMBR(N-1)+1) GO TO 440
      CCR(N)=RAD(N)/(TIME(N)-TIME(N-1))
      GO TO 450
  440 CCR(N)=RAD(N)/SEC
  450 CONTINUE
C
C     COMPUTE THE MEAN AND STANDARD DEVIATION OF THE BACKGROUND COUNT
C     RATE FROM THE RADIATION DATA THAT LIES WITHIN THE LIMITS OF THE
C     ESTIMATED BACKGROUND COUNT RATE SET BY CHAUVENET'S CRITERION.
C
      IF (CCR(1).GT.2.*BKG) CCR(1)=BKG
      ALPHA=1.-1./FLOAT(2*LINE)
      CALL TINORM (CHVR,ALPHA,$455)
      GO TO 460
  455 CHVR=5.
      WRITE (6,770) ALPHA
  460 BGCR=0.0
      SIGMA=0.0
      NCOUNT=0
      GATE1=BKG-CHVR*SQRT(BKG/SEC)
      GATE2=BKG+CHVR*SQRT(BKG/SEC)
      DO 490 N=1,LINE
      IF (CCR(N)-GATE1) 490,490,470
  470 IF (CCR(N)-GATE2) 480,490,490
  480 NCOUNT=NCOUNT+1
      BGCR=BGCR+CCR(N)
  490 CONTINUE
      BGCR=BGCR/FLOAT(NCOUNT)
      DO 520 N=1,LINE
      IF (CCR(N)-GATE1) 520,520,500
  500 IF (CCR(N)-GATE2) 510,520,520
  510 SIGMA=SIGMA+(CCR(N)-BGCR)**2
  520 CONTINUE
      SIGMA=SQRT(SIGMA/FLOAT(NCOUNT))
      WRITE (6,780) BKG,BGCR,SIGMA
C
C     CALL THE SUBROUTINE FOR PLOTTING UNCORRECTED RADIATION VALUES
C
      NENTRY=2
      IF (NOPT(2).EQ.1) CALL RADPLT (NCORD,ECORD,CCR)
      IF (NOPT(3).NE.1) GO TO 570
C
C     CORRECT RADIATION VALUES FOR BACKGROUND COUNT RATE AND TIME-DECAY
C
      SUM=0.0
      NBAR=0.0
      EBAR=0.0
      SDNRTH=0.0
      SDEAST=0.0
      DO 540 N=1,LINE
      CCR(N)=CCR(N)-BGCR
      IF(CCR(N)-3.*SIGMA) 540,540,530
  530 CCR(N)=(CCR(N)-3.*SIGMA)*EXP(DECAY*(DELAY+TIME(N)/3600.))
     1 + 3.*SIGMA
      SUM=SUM+CCR(N)
      NBAR=NBAR+(NCORD(N)-NCORD(1))*CCR(N)
      EBAR=EBAR+(ECORD(N)-ECORD(1))*CCR(N)
  540 CONTINUE
      WRITE (6,790) SUM
C
C     COMPUTE WEIGHTED MEAN AND STD. DEV. OF ACTIVITY LOCA).ON
C
      NBAR=NCORD(1)+NBAR/SUM
      EBAR=ECORD(1)+EBAR/SUM
      DO 560 N=1,LINE
      IF (CCR(N)) 560,560,550
```

```
229   550  SDNRTH=SDNRTH+(NCORD(N)-NBAR)*(NCORD(N)-NBAR)*CCR(N)
230        SDEAST=SDEAST+(ECORD(N)-EBAR)*(ECORD(N)-EBAR)*CCR(N)
231   560  CONTINUE
232        SDNRTH=SQRT(SDNRTH/SUM)
233        SDEAST=SQRT(SDEAST/SUM)
234        WRITE (6,800) NBAR,EBAR,SDNRTH,SDEAST
      C
      C    COMPUTE AND PRINT 95 PC. CONFIDENCE LIMITS OF MEAN RADIATION
      C    LOCATION.
      C
235        RTSUM=SQRT(SUM/BGCR)
236        CFIDN=1.96*SDNRTH/RTSUM
237        CFIDE=1.96*SDEAST/RTSUM
238        WRITE (6,810) CFIDN,CFIDE
239   570  NENTRY=3
240        IF (NOPT(3).EQ.1) CALL RADPLT (NCORD,ECORD,CCR)
241        WRITE (6,820) NMAX,EMAX
242        WRITE (6,830) NMIN,EMIN
      C
      C    WRITE OUT THE NUMBER, COORDINATES AND ACTIVITY OF EACH DATA POINT
      C
243        KOUNT=50
244        DO 600 N=1,LINE
245        IF (KOUNT-50) 590,580,580
246   580  WRITE (6,840) LEGEND
247        KOUNT=0
248   590  WRITE (6,850) NMBR(N),TIME(N),NORTH(N),EAST(N),NCORD(N),ECORD(N),C
          1CR(N),FATH(N)
249   600  KOUNT=KOUNT+1
250        WRITE (6,860)
251        IF (.NOT.JOBEND) GO TO 10
252        STOP
      C
253   610  FORMAT (1H1)
254   620  FORMAT (3F3.0,F7.0,8X,2F2.0,F3.0,F5.2,3F2.0,4(1X,F7.0),I3)
255   630  FORMAT (4I1,F10.0,1X,3I2,1X,F10.0,2(1X,F10.0),1X,A6)
256   640  FORMAT (13A6,L2)
257   650  FORMAT (10X,13A6,10X,L2)
258   660  FORMAT (/5X,8HBEACON 1,F10.0,1HN,F10.0,1HE,5X,8HBEACON 2,F10.0,1HN
          1,F10.0,1HE//)
259   670  FORMAT (5X,21HSQUARE DIST BETWEEN =,E16.8,5X,18HDISTANCE BETWEEN =
          1,F10.0)
260   680  FORMAT (5X,6HSINE =,E16.8,5X,8HCOSINE =,E16.8)
261   690  FORMAT (5X,16HINJECTION TIME =,2F3.0,10X,12HCLOCK SET AT,2F3.0,5X,
          121HDIGITIZING INTERVAL =,F3.0,7HSECONDS/5X,30HDAYS ELAPSED SINCE I
          2NJECTION =,F3.0)
262   700  FORMAT (5X,22HHALF-LIFE OF ISOTOPE =,F7.2,4HDAYS,5X,14HDECAY FACTO
          1R =,E16.8,5X,19HTIME-DELAY FACTOR =,F7.2,5HHOURS)
263   710  FORMAT (10X,14HCABLE LENGTH =,F4.0,10X,18HMEAN WATER DEPTH =,F4.0,
          110X,13HBOAT LENGTH =,F4.0)
264   720  FORMAT (10X,38HDISTANCE FROM RADAR MAST TO DETECTOR =,F6.1,5HFEET.
          1)
265   730  FORMAT (//40X,15HPLOTS GENERATED/10X,9HTRACKLINE,I5,10X,20HBACKGRO
          1UND RADIATION,I5,10X,19HCORRECTED RADIATION,I5)
266   740  FORMAT (5X,51HBEACON RANGES FOR DUMP SITE COMPUTE IMAGINARY ROOT.)
267   750  FORMAT (10X,37HLAMBERT COORDINATES OF INJECTION SITE,F10.0,1HN,F10
          1.0,1HE)
268   760  FORMAT (I6,3F7.1,F7.0,7X,F7.0,A1)
269   770  FORMAT (37H THERE WAS AN OVERFLOW WHEN ALPHA WAS,F6.3,5X,25HCHVR W
          1AS SET EQUAL TO 5.0)
270   780  FORMAT (//20X,53HSUMMARY STATISTICS OF BACKGROUND RADIATION COUNT
          1RATE/10X,21HEST. BKG. COUNTS/SEC.,F10.0/10X,21HMEAN BKG. COUNTS/SE
          2C.,F10.0/10X,21HSTD. DEV. COUNTS/SEC.,F10.0)
271   790  FORMAT (//10X,33HSUM OF CORRECTED RADIATION COUNTS,E16.8)
272   800  FORMAT (//20X,41HSUMMARY STATISTICS OF RADIATION LOCATION./24X,11H
          1NORTH COORD,10X,10HEAST COORD/16X,4HMEAN,5X,F10.0,10X,F10.0/11X,9H
          2STD. DEV.,5X,F10.0,10X,F10.0)
273   810  FORMAT (10X,10HCONFIDENCE/7X,13HLIMIT OF MEAN,5X,F10.0,10X,F10.0)
274   820  FORMAT (//7X,13HMAXIMUM COORD,5X,F10.0,1HN,9X,F10.0,1HE)
275   830  FORMAT (//7X,13HMINIMUM COORD,5X,F10.0,1HN,9X,F10.0,1HE//)
276   840  FORMAT (1H1,9X,13A6//2X,50HLINE  TIME  DISTANCE TO BEACON    BOAT
          1COORDTNATES,4X,50HBALL COORDINATES  UNCORRECTED  CORRECTED     DEP
          2TH/9X,3HSEC,8X,1H1,9X,1H2,6X,5HNORTH,6X,4HEAST,5X,5HNORTH,6X,4HEAS
          3T,4X,20HRADIATION COUNTS/SEC,6X,4HFEET)
277   850  FORMAT (1X,I5,F6.0,20X,4F10.0,13X,F11.0,F10.0)
278   860  FORMAT (1H1)
279        END
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PROGRAM -- RAPLOT III MODIFIED FOR IBM-7094 WITH SC-4060. CRT

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 10 | - | 10* | 251 | | | | | | | |
| 20 | - | 14 | 15* | | | | | | | |
| 30 | - | 13 | 14 | 16* | | | | | | |
| 40 | - | 36 | 37* | | | | | | | |
| 50 | - | 41 | 42* | | | | | | | |
| 60 | - | 41 | 45* | | | | | | | |
| 70 | - | 36 | 44 | 49* | | | | | | |
| 80 | - | 50* | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 63 |
| 90 | - | 53 | 54* | | | | | | | |
| 100 | - | 53 | 61 | 64* | | | | | | |
| 110 | - | 73 | 74* | | | | | | | |
| 120 | - | 69 | 76* | | | | | | | |
| 130 | - | 67 | 78* | | | | | | | |
| 140 | - | 81 | 82* | | | | | | | |
| 150 | - | 84 | 85* | | | | | | | |
| 160 | - | 83 | 86* | | | | | | | |
| 170 | - | 80 | 81 | 84 | 87* | | | | | |
| 180 | - | 89 | 90* | | | | | | | |
| 190 | - | 92 | 93* | | | | | | | |
| 200 | - | 91 | 92 | 95* | | | | | | |
| 210 | - | 94 | 96* | | | | | | | |
| 220 | - | 99* | 101 | | | | | | | |
| 230 | - | 88 | 89 | 101 | 102* | | | | | |
| 240 | - | 79 | 103* | | | | | | | |
| 250 | - | 110 | 111* | | | | | | | |
| 260 | - | 110 | 114* | | | | | | | |
| 270 | - | 105 | 113 | 117* | | | | | | |
| 280 | - | 120* | 159 | | | | | | | |
| 290 | - | 122 | 123* | | | | | | | |
| 300 | - | 122 | 125* | | | | | | | |
| 310 | - | 128 | 129* | | | | | | | |
| 320 | - | 121 | 124 | 133* | | | | | | |
| 330 | - | 118 | 119 | 135 | 136* | | | | | |
| 335 | - | 143* | | | | | | | | |
| 340 | - | 142 | 145* | | | | | | | |
| 350 | - | 151 | 152* | | | | | | | |
| 360 | - | 152 | 153* | | | | | | | |
| 370 | - | 153 | 154* | | | | | | | |
| 380 | - | 151 | 152 | 153 | 154 | 155* | | | | |
| 390 | - | 150 | 154 | 157* | | | | | | |
| 400 | - | 135 | 158 | 160* | | | | | | |
| 410 | - | 169 | 170* | | | | | | | |
| 420 | - | 169 | 173* | | | | | | | |
| 430 | - | 167 | 172 | 175* | | | | | | |
| 440 | - | 178 | 181* | | | | | | | |
| 450 | - | 177 | 180 | 182* | | | | | | |
| 455 | - | 187* | | | | | | | | |
| 460 | - | 186 | 189* | | | | | | | |
| 470 | - | 195 | 196* | | | | | | | |
| 480 | - | 196 | 197* | | | | | | | |
| 490 | - | 194 | 195 | 196 | 199* | | | | | |
| 500 | - | 202 | 203* | | | | | | | |
| 510 | - | 203 | 204* | | | | | | | |
| 520 | - | 201 | 202 | 203 | 205* | | | | | |
| 530 | - | 218 | 219* | | | | | | | |
| 540 | - | 216 | 218 | 223* | | | | | | |
| 550 | - | 228 | 229* | | | | | | | |
| 560 | - | 227 | 228 | 231* | | | | | | |
| 570 | - | 210 | 239* | | | | | | | |
| 580 | - | 245 | 246* | | | | | | | |
| 590 | - | 245 | 248* | | | | | | | |
| 600 | - | 244 | 249* | | | | | | | |
| 610 | - | 7WR | 253* | | | | | | | |
| 620 | - | 11RD | 254* | | | | | | | |
| 630 | - | 12RD | 255* | | | | | | | |
| 640 | - | 17RD | 256* | | | | | | | |
| 650 | - | 18WR | 257* | | | | | | | |
| 660 | - | 19WR | 258* | | | | | | | |
| 670 | - | 22WR | 259* | | | | | | | |
| 680 | - | 25WR | 260* | | | | | | | |
| 690 | - | 26WR | 261* | | | | | | | |
| 700 | - | 31WR | 262* | | | | | | | |
| 710 | - | 32WR | 263* | | | | | | | |
| 720 | - | 34WR | 264* | | | | | | | |
| 730 | - | 35WR | 265* | | | | | | | |
| 740 | - | 43WR | 266* | | | | | | | |
| 750 | - | 48WR | 267* | | | | | | | |
| 760 | - | 51RD | 268* | | | | | | | |
| 770 | - | 144WR | 188WR | 269* | | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 780 | - | 207WR | 270* | | | | | | | | |
| 790 | - | 224WR | 271* | | | | | | | | |
| 800 | - | 234WR | 272* | | | | | | | | |
| 810 | - | 238WR | 273* | | | | | | | | |
| 820 | - | 241WR | 274* | | | | | | | | |
| 830 | - | 242WR | 275* | | | | | | | | |
| 840 | - | 246WR | 276* | | | | | | | | |
| 850 | - | 248WR | 277* | | | | | | | | |
| 860 | - | 250WR | 278* | | | | | | | | |
| AA | - | 1CO | | | | | | | | | |
| ABS | - | 84 | | | | | | | | | |
| ALOG | - | 30 | | | | | | | | | |
| ALPHA | - | 140= | 141AG | 144WR | 184= | 185AG | 188WR | | | | |
| BEAC1E | - | 11RD | 19WR | 20 | 24 | 46 | 115 | | | | |
| BEAC1N | - | 11RD | 19WR | 20 | 23 | 47 | 116 | | | | |
| BEAC2E | - | 11RD | 19WR | 20 | 24 | | | | | | |
| BEAC2N | - | 11RD | 19WR | 20 | 23 | | | | | | |
| BGCR | - | 1CO | 189= | 198= | 200= | 204 | 207WR | 217 | 235 | | |
| BKG | - | 11RD | 183 | 192 | 193 | 207WR | | | | | |
| BOAT | - | 11RD | 32WR | 33 | | | | | | | |
| CABLE | - | 11RD | 32WR | 33= | 34WR | 165 | 166 | 169 | 170 | 171 | |
| CCR | - | 3DI | 4EQ | 176= | 179= | 181= | 183 | 195 | 196 | 198 | 202 |
| | | 203 | 204 | 209AG | 217= | 218 | 219= | 220 | 221 | 222 | 228 |
| | | 229 | 230 | 240AG | 248WR | | | | | | |
| CFIDE | - | 237= | 238WR | | | | | | | | |
| CFIDN | - | 236= | 238WR | | | | | | | | |
| CHECK | - | 52 | | | | | | | | | |
| CHVR | - | 141AG | 143= | 145 | 146 | 147 | 148 | 185AG | 187= | 192 | 193 |
| CORR1 | - | 6DA | 37 | 106 | | | | | | | |
| CORR2 | - | 6DA | 38 | 107 | | | | | | | |
| COSINE | - | 24= | 25WR | 46 | 47 | 115 | 116 | | | | |
| D | - | 3DI | 4EQ | 51RD | 57 | 58 | 74= | 81 | 84 | 85= | 89 |
| | | 92 | 97 | 99= | 106 | 107 | 129= | | | | |
| DAYS | - | 11RD | 26WR | 29 | | | | | | | |
| DD1 | - | 97= | 99 | | | | | | | | |
| DEO | - | 163= | 164 | 166 | | | | | | | |
| DECAY | - | 30= | 31WR | 219 | | | | | | | |
| DELAY | - | 29= | 31WR | 219 | | | | | | | |
| DENOM | - | 164= | 165 | 166 | 168= | 169 | 170 | 171 | | | |
| DEPTH | - | 11RD | 32WR | 33 | | | | | | | |
| DFT1 | - | 106= | 108 | 109 | | | | | | | |
| DFT2 | - | 107= | 108 | | | | | | | | |
| DISTB | - | 21= | 22WR | 23 | 24 | 39 | 108 | | | | |
| DNO | - | 162= | 164 | 165 | | | | | | | |
| DTIME | - | 96= | 99 | | | | | | | | |
| DUMP1 | - | 12RD | 36 | 37= | 39 | 40 | | | | | |
| DUMP2 | - | 12RD | 38= | 39 | | | | | | | |
| DUMPE | - | 1CO | | | | | | | | | |
| DUMPN | - | 1CO | | | | | | | | | |
| DX1 | - | 39= | 40 | 46 | 47 | 108= | 109 | 115 | 116 | | |
| DY1 | - | 40= | 41 | 45= | 46 | 47 | 109= | 110 | 114= | 115 | 116 |
| E | - | 52AG | 53 | | | | | | | | |
| EAST | - | 3DI | 115= | 131= | 139AG | 151 | 152 | 161AG | 163 | 164 | 166 |
| | | 168 | 171 | 248WR | | | | | | | |
| EBAR | - | 1CO | 138= | 139AG | 145 | 146 | 213= | 222= | 226= | 230 | 234WR |
| ECORD | - | 3DI | 4EQ | 166= | 168 | 171= | 174= | 209AG | 222 | 226 | 230 |
| | | 240AG | 248WR | | | | | | | | |
| EMAX | - | 1CO | 241WR | | | | | | | | |
| EMIN | - | 1CO | 242WR | | | | | | | | |
| EXP | - | 219 | | | | | | | | | |
| FATH | - | 3DI | 51RD | 60 | 76= | 248WR | | | | | |
| FLOAT | - | 140 | 184 | 200 | 206 | | | | | | |
| GATE1 | - | 145= | 151 | 192= | 195 | 202 | | | | | |
| GATE2 | - | 146= | 152 | 193= | 196 | 203 | | | | | |
| GATEN1 | - | 147= | 153 | | | | | | | | |
| GATEN2 | - | 148= | 154 | | | | | | | | |
| GRID | - | 1CO | 12RD | | | | | | | | |
| HLIFE | - | 11RD | 30 | 31WR | | | | | | | |
| I | - | 12RD | 13 | 14 | 15 | 35WR | 73 | 74 | 79 | 81 | 84 |
| | | 85 | 89 | 92 | 97 | 99 | 128 | 129 | | | |
| IFLAG | - | 6DA | 54 | | | | | | | | |
| INDATE | - | 1CO | 12RD | | | | | | | | |
| ISKIP | - | 11RD | 67 | 68 | 70 | 77 | | | | | |
| JFLAG | - | 51RD | 54 | | | | | | | | |
| JOBEND | - | 1CO | 5LG | 17RD | 18WR | 251 | | | | | |
| KEY | - | 119= | 135 | 158= | | | | | | | |
| KOUNT | - | 243= | 245 | 247= | 249= | | | | | | |
| LAG | - | 104= | 112= | 118 | 120= | 123= | 125 | 134 | 149= | 156= | 159 |

PROGRAM -- RAPLOT III MODIFIED FOR IBM-7094 WITH SC-4060 CRT

```
LEGEND  -    1CO     17RD    18WR    246WR
LINE    -    1CO     66=     69      77=     78      83      91      105     121     134=
             137AG   139AG   150     167     177     194     201     216     227     244
M       -    80      81      82      84      88      89      90
MSTOP   -    78=     80      88
N       -    49=     51RD    55      56      57      58      59      60      61      62=
             65=     66      69      70      71      72      74      75      76      83
             84      85      91      92      93      98=     99      100=    101     105
             106     107     111     115     116     121     122     125     126     127
             129     130     131     132     150     151     152     153     154     155
             167     168     170     171     173     174     177     178     179     181
             194     195     196     198     201     202     203     204     216     217
             218     219     220     221     222     227     228     229     230     244
             248WR
NBAR    -    1CO     2RL     136=    137AG   147     148     212=    221=    225=    229
             234WR
NCALLS  -    1CO     9=      10=
NCAM    -    1CO     8=
NCORD   -    2RL     4EQ     165=    168     170=    173=    209AG   221     225     229
             240AG   248WR
NCOUNT  -    191=    197=    200     206
NENTRY  -    1CO     160=    208=    239=
NMAX    -    1CO     2RL     241WR
NMBR    -    3DI     51RD    55      71=     126=    161AG   178     248WR
NMIN    -    1CO     2RL     242WR
NN      -    70=     71      72      74      75      76      125=    126     127     129
             130     131     132
NOPT    -    1CO     12RD    35WR    161     209     210     240
NORTH   -    2RL     111=    116=    122     132=    137AG   153     154     155=    161AG
             162     164     165     168     170     248WR
NPLT    -    1CO     12RD    14      15=
NSTART  -    68=     69      82=     83      90=     91      96      97      98      99
NSTOP   -    93=     96      97      101
RAD     -    3DI     4EQ     51RD    59      75=     130=    176     179     181
RADPLT  -    209     240
RESET   -    50
RMIN    -    11RD    26WR    28
RTSUM   -    235=    236     237
SCALE   -    1CO     12RD
SDEAST  -    139AG   145     146     215=    230=    233=    234WR   237
SDNRTH  -    137AG   147     148     214=    229=    232=    234WR   236
SEC     -    11RD    26WR    176     181     192     193
SETIME  -    11RD    26WR    28=     29
SIGMA   -    1CO     190=    204=    206=    207WR   218     219
SINE    -    23=     25WR    46      47      115     116
SITEE   -    46=     48WR
SITEN   -    42=     47=     48WR
SQDSTB  -    20=     21      22WR    39      108
SQRT    -    21      33      45      114     164     168     192     193     206     232
             233     235
STDEV   -    137     139
STOP    -    252
SUM     -    211=    220=    224WR   225     226     232     233     235
TIME    -    3DI     51RD    56      72=     84      96      99      127=    179     219
             248WR
TINORM  -    141     185
TRACK   -    161
ZHR     -    11RD    26WR    27=     29
ZMIN    -    11RD    26WR    27

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```
      SUBROUTINE TRACK (NORTH,EAST,NMBR)                                TRK   1
C                                                                       TRK   2
C     THIS SUBROUTINE GENERATES PLOT INSTRUCTIONS FOR THE STROMBERG-    TRK   3
C     CARLSON 4020 CATHODE RAY TUBE.                                    TRK   4
C                                                                       TRK   5
      COMMON /AA/ NOPT(4),NPLT(3),SCALE,GRID,DUMPN,DUMPE,NBAR,EBAR,LEGENTRK   6
     1D(13),INDATE,NPTS,BGCR,SIGMA,NMAX,NMIN,EMAX,EMIN,JOBEND,NENTRY,NCATRK   7
     2LLS,NCAM                                                          TRK   8
      DIMENSION EAST(2000), NMBR(2000)                                  TRK   9
      REAL NORTH(2000),NBAR,NMAX,NMIN,NMAXV                             TRK  10
      LOGICAL JOBEND                                                    TRK  11
   10 IF (NCALLS.GT.1) GO TO 20                                         TRK  12
C                                                                       TRK  13
C     INITIALIZE CAMERA, AND PRINT ID FRAME                             TRK  14
C                                                                       TRK  15
      PHI=ALOG(2.)                                                      TRK  16
      CALL FRAMEV                                                       TRK  17
      CALL SETMIV (0,140,32,0)                                          TRK  18
   20 LAST=3                                                            TRK  19
   30 IF (NOPT(LAST).NE.0) GO TO 40                                     TRK  20
      LAST=LAST-1                                                       TRK  21
      GO TO 30                                                          TRK  22
C                                                                       TRK  23
C     COMPUTE MAXIMUM AND MINIMUM VALUES OF NORTH AND EAST ARRAYS       TRK  24
C                                                                       TRK  25
   40 NMAX=NORTH(1)                                                     TRK  26
      NMIN=NORTH(1)                                                     TRK  27
      EMAX=EAST(1)                                                      TRK  28
      EMIN=EAST(1)                                                      TRK  29
      DO 50 N=2,NPTS                                                    TRK  30
      NMAX=AMAX1(NMAX,NORTH(N))                                         TRK  31
      NMIN=AMIN1(NMIN,NORTH(N))                                         TRK  32
      EMAX=AMAX1(EMAX,EAST(N))                                          TRK  33
   50 EMIN=AMIN1(EMIN,EAST(N))                                          TRK  34
      XRATIO=(EMAX-EMIN)/883.                                           TRK  35
      YRATIO=(NMAX-NMIN)/991.                                           TRK  36
      IF (XRATIO-YRATIO) 60,80,70                                       TRK  37
   60 EMAXV=EMIN+YRATIO*883.                                            TRK  38
      NMAXV=NMAX                                                        TRK  39
      GO TO 80                                                          TRK  40
   70 NMAXV=NMIN+XRATIO*991.                                            TRK  41
      EMAXV=EMAX                                                        TRK  42
      GO TO 80                                                          TRK  43
      ENTRY RADPLT(NORTH,EAST,RAD)                                      TRK 435
      DIMENSION RAD(2000)                                               TRK  44
      IF (NOPT(1).EQ.0.AND.NENTRY.EQ.2) GO TO 10                        TRK  45
      IF (NOPT(1).EQ.0.AND.NOPT(2).EQ.0.AND.NENTRY.EQ.3) GO TO 10       TRK  46
C                                                                       TRK  47
C     PRINT LEGEND AND INJECTION DATE AT BASE OF MAP.                   TRK  48
C                                                                       TRK  49
   80 CALL PRINTV (78,LEGEND,24,24)                                     TRK  50
      CALL PRINTV (-14,14HINJECTION DATE,720,8)                         TRK  51
      CALL PRINTV (6,INDATE,848,8)                                      TRK  52
      NN=NPLT(NENTRY)                                                   TRK  53
      GO TO (90,110,140), NENTRY                                        TRK  54
   90 CALL PRINTV (-25,25HPLOT OF SURVEY TRACK LINE,24,8)               TRK  55
      CALL GRID1V (2,EMIN,EMAXV,NMIN,NMAXV,SCALE,SCALE,5,5,5,5,-5,-4)   TRK  56
C                                                                       TRK  57
C     PLOT TRACK LINE FOLLOWED BY SURVEY VESSEL                         TRK  58
C                                                                       TRK  59
      DO 100 N=2,NPTS                                                   TRK  60
      CALL LINEV (NXV(EAST(N-1)),NYV(NORTH(N-1)),NXV(EAST(N)),NYV(NORTH(TRK  61
     1N)))                                                              TRK  62
      IF (MOD(N,NN).NE.0) GO TO 100                                     TRK  63
      CALL POINTV (EAST(N),NORTH(N),-3)                                 TRK  64
      D=FLOAT(NMBR(N))                                                  TRK  65
      IX=NXV(EAST(N))+5                                                 TRK  66
C                                                                       TRK  67
C     PLOT FIX NUMBER OF EVERY NNTH FIX                                 TRK  68
C                                                                       TRK  69
      CALL LABLV (D,IX,NYV(NORTH(N)),4,1,4)                             TRK  70
  100 CONTINUE                                                          TRK  71
      GO TO 220                                                         TRK  72
  110 CALL PRINTV (-62,62HPLOT OF UNCORRECTED RADIATION IN STD. DEVS. FRTRK  73
     1OM MEAN BKG. CR.,24,8)                                            TRK  74
      CALL GRID1V (2,EMIN,EMAXV,NMIN,NMAXV,SCALE,SCALE,5,5,5,5,-5,-4)   TRK  75
C                                                                       TRK  76
C     PLOT UNCORRECTED RADIATION VALUES IN STANDARD DEVIATIONS FROM MEANTRK  77
C     BACKGROUND COUNT RATE                                             TRK  78
C                                                                       TRK  79
```

```
      DO 120 N=1,NPTS
      IF (MOD(N,NN).NE.0) GO TO 120
      IVAL=IFIX((RAD(N)-BGCR)/SIGMA+6.)
      IF (IVAL.LT.0) IVAL=0
      IF (IVAL.GT.11) IVAL=11
      IVAL=-IVAL
      CALL POINTV (EAST(N),NORTH(N),IVAL)
  120 CONTINUE
C
C     PRINT LEGEND FOR SYMBOLS REPRESENTING UNCORRECTED VALUES
C
      CALL PRINTV (-6,6HLEGEND,912,800)
      CALL POINTV (887,768,0,ANY)
      CALL PRINTV (-8,8HCCR .LE.,903,768)
      D=BGCR-5.*SIGMA
      CALL LABLV (D,975,768,6,1,6)
      IY=752
      DO 130 I=1,11
      N=-I
      CALL POINTV (887,IY,N,ANY)
      CALL PRINTV (-8,8HCCR .GT.,903,IY)
      CALL LABLV (D,975,IY,6,1,6)
      D=D+SIGMA
  130 IY=IY-16
      GO TO 220
  140 CALL PRINTV (-38,38HPLOT OF CORRECTED RADIATION COUNT RATE,24,8)
      CALL GRID1V (2,EMIN,EMAXV,NMIN,NMAXV,SCALE,SCALE,5,5,5,5,-5,-4)
C
C     PLOT CORRECTED RADIATION COUNT RATE AS BACKGROUND IF .LT. 3 STD.
C     DEVS. FROM BACKGROUND.  IF COUNT RATE IS MORE THAN 3 STD. DEVS.
C     BELOW BACKGROUND, THE VALUE IS NOT PLOTTED AT ALL.
C
      DO 190 N=1,NPTS
      IF (MOD(N,NN).NE.0) GO TO 190
      IF (RAD(N)+3.*SIGMA) 190,160,150
  150 IF (RAD(N)-3.*SIGMA) 160,160,170
  160 IVAL=0
      GO TO 180
C
C     IF THE COUNT RATE IS .G.. BACKGROUND, THE VALUE IS PLOTTED ON A
C     POWER OF 2 *  25 SCALE
C
  170 IVAL=IFIX(ALOG(RAD(N)/100.)/PHI+3.)
      IF (IVAL.LT.1) IVAL=1
      IF (IVAL.GT.12) IVAL=12
      IVAL=-IVAL
  180 CALL POINTV (EAST(N),NORTH(N),IVAL)
  190 CONTINUE
C
C     PRINT LEGEND FOR SYMBOLS REPRESENTING CORRECTED VALUES
C
      CALL PRINTV (-6,6HLEGEND,912,800)
      CALL POINTV (887,768,0,ANY)
      CALL PRINTV (-8,8HCCR .LE.,903,768)
      D=3.*SIGMA
      CALL LABLV (D,975,768,6,1,6)
      D=25.
      IY=752
      DO 200 I=1,12
      N=-I
      CALL POINTV (887,IY,N,ANY)
      CALL PRINTV (-8,8HCCR .GE.,903,IY)
      CALL LABLV (D,975,IY,6,1,6)
      D=D*2.
  200 IY=IY-16
C
C     PLOT MEAN RADIATION LOCATION
C
      IX=NXV(EBAR)
      IY=NYV(NBAR)
      CALL POINTV (IX,IY,0,ANY)
      CALL PRINTV (-8,8HO RADBAR,IX,IY)
C
C     PLOT POSITION OF INJECTION SITE
C
      IF (DUMPN.GT.NMAX.OR.DUMPN.LT.NMIN) GO TO 210
      IX=NXV(DUMPE)
      IY=NYV(DUMPN)
```

SUBROUTINE TRACK (NORTH,EAST,NMBR)

```
 111            CALL POINTV (IX,IY,0,ANY)                                      TRK 158
 112            CALL PRINTV (-6,6HO DUMP,IX,IY)                                TRK 159
 113      210   CONTINUE                                                       TRK 160
 114      220   CALL FRAMEV (2)                                                TRK 161
 115            IF (.NOT.JOBEND.OR.NENTRY.NE.LAST) RETURN                      TRK 162
 116            RETURN                                                         TRK 163
 117            END                                                            TRK 164-
```

SUBROUTINE TRACK (NORTH,EAST,NMBR)

```
SYMBOL     = = = = = = = = = = = = = = =    REFERENCES    = = = = = = = = = = = = = = =

10       -    6*     34     35
20       -    6      10*
30       -   11*     13
40       -   11      14*
50       -   18      22*
60       -   25      26*
70       -   25      29*
80       -   25      28     31     36*
90       -   40      41*
100      -   43      45     50*
110      -   40      52*
120      -   54      55     61*
130      -   68      74*
140      -   40      76*
150      -   80      81*
160      -   80      81     82*
170      -   81      84*
180      -   83      88*
190      -   78      79     80     89*
200      -   97      103*
210      -   108     113*
220      -   51      75     114*
AA       -    2CO
ALOG     -    7      84
AMAX1    -   19      21
AMIN1    -   20      22
ANY      -   70AG    99AG
BGCR     -    2CO    56     65
D        -   47=     49AG   65=    66AG   72AG   73=    93=    94AG   95=    101AG
             102=
DUMPE    -    2CO    109
DUMPN    -    2CO    108    110
EAST     -    1AG     3DI   16     17     21     22     32     44AG   46AG   48
             60AG    88AG
EBAR     -    2CO    104
EMAX     -    2CO    16=    21=    23     30
EMAXV    -   26=     30=    42AG   53AG   77AG
EMIN     -    2CO    17=    22=    23     26     42AG   53AG   77AG
FLOAT    -   47
FRAMEV   -    8      114
GRID     -    2CO
GRID1V   -   42      53     77
I        -   68      69     97     98
IFIX     -   56      84
INDATE   -    2CO    38AG
IVAL     -   56=     57     58     59=    60AG   82=    84=    85     86     87=
             88AG
IX       -   48=     49AG   104=   106AG  107AG  109=   111AG  112AG
IY       -   67=     70AG   71AG   72AG   74=    96=    99AG   100AG  101AG  103=
             105=    106AG  107AG  110=   111AG  112AG
JOBEND   -    2CO     5LG   115
LABLV    -   49      66     72     94     101
LAST     -   10=     11     12=    115
LEGEND   -    2CO    36AG
LINEV    -   44
MOD      -   45      55     79
N        -   18      19     20     21     22     43     44AG   45     46AG   47
             48      49AG   54     55     56     60AG   69=    70AG   78     79
             80      81     84     88AG   98=    99AG
NBAR     -    2CO     4RL   105
NCALLS   -    2CO     6
NCAM     -    2CO
NENTRY   -    2CO    34     35     39     40     115
NMAX     -    2CO     4RL   14=    19=    24     27     108
NMAXV    -    4RL    27=    29=    42AG   53AG   77AG
NMBR     -    1AG     3DI   47
```

SUBROUTINE TRACK (NORTH,EAST,NMBR)

```
NMIN    -   2CO    4RL    15=    20=    24     29     42AG   53AG   77AG   108
NN      -  39=    45     55     79
NOPT    -   2CO   11     34     35
NORTH   -   1AG    4RL   14     15     19     20     32     44AG   46AG   49AG
           60AG   88AG
NPLT    -   2CO   39
NPTS    -   2CO   18     43     54     78
NXV     -  44AG   48    104    109
NYV     -  44AG   49AG  105    110
PHI     -   7=    84
POINTV  -  46     60     63     70     88     91     99    106    111
PRINTV  -  36     37     38     41     52     62     64     71     76     90
           92    100    107    112
RAD     -  32     33DI   56     80     81     84
RADPLT  -  32
RETURN  - 115    116
SCALE   -   2CO   42AG   53AG   77AG
SETMIV  -   9
SIGMA   -   2CO   56     65     73     80     81     93
TRACK   -   1
XRATIO  -  23=    25     29
YRATIO  -  24=    25     26
```

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I N D E X

SUBROUTINE TINORM(ZVAL,ALPHA,*)

```
 1          SUBROUTINE TINORM(ZVAL,ALPHA,*)                                          TINORM
 2          DIMENSION A(3), B(3)                                                     TINORM
 3          DATA(A(I),I=1,3)/.010328,.802853,2.515517/,(B(I),I=1,3)/.0010308,        TINORM
           1.189269,1.432788/                                                        TINORM
      C-----------------------------------------------------------------------------TINORM
      C     APPROXIMATION TO INVERSE NORMAL DISTRIBUTION                             TINORM
      C-----------------------------------------------------------------------------TINORM
 4          IF(.NOT.(ALPHA.GT.0..AND.ALPHA.LT.1.)) GO TO 1                           TINORM
 5          X=ALPHA                                                                  TINORM
 6          IF(X.GT..5) X=1.-X                                                       TINORM
 7          X=SQRT(-2.*ALOG(X))                                                      TINORM
 8          ZVAL  =X-(A(3)+X*(A(2)+X*A(1)))/(1.+X*(B(3)+X*(B(2)+X* B(1))))           TINORM
 9          CALL OVERFL(I)                                                           TINORM
10          IF(I.EQ.1) RETURN 3                                                      TINORM
11          IF(ALPHA.LT..5) ZVAL = - ZVAL                                            TINORM
12          RETURN                                                                   TINORM
13        1 RETURN 3                                                                 TINORM
14          END                                                                      TINORM
```

I N D E X

SUBROUTINE TINORM(ZVAL,ALPHA,*)

```
SYMBOL     = = = = = = = = = = = = = = =    REFERENCES    = = = = = = = = = = = = = = =

1       -   4     13*
A       -   2DI    3DA    8
ALOG    -   7
ALPHA   -   1AG    4      5     11
B       -   2DI    3DA    8
I       -   3DA    9AG   10
OVERFL  -   9
RETURN  -  10     12     13
SQRT    -   7
TINORM  -   1
X       -   5=     6      7=     8
ZVAL    -   1AG    8=    11=
```

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**13. ABSTRACT**

RAPLOT II is a computer program for processing radiation and navigation data from field surveys of radioisotopic sand tracer (RIST) study, but is applicable to any survey type operation on the nearshore Continental Shelf. Collected data are punched onto paper tape by the data collection computer on the research vessel. The data are later transferred to magnetic tape which provides the input for the RAPLOT II Program. Program control parameters are on punched cards. The navigation data, which consists of ranges to two shore-based radar beacons, are first edited for spurious data, and then converted to rectangular coordinates (in this case the California Lambert Coordinate System). Radiation data are converted to count rate as counts per second. Background count rate is computed and subtracted from the observed count rate, and any radiation counts that are significantly above the background count rate are corrected for time of decay since the isotope was injected.

Output from the program is in three forms - printed output, graphical output, and magnetic tape record. The processed data are transferred to magnetic tape and made available for further processing, such as the generation of contour maps.

| 14. KEY WORDS | LINK A | | LINK B | | LINK C | |
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| | ROLE | WT | ROLE | WT | ROLE | WT |
| Computer Program | | | | | | |
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| Radioisotopic sand tracer | | | | | | |
| Continental Shelf | | | | | | |
| Hydrographic Survey | | | | | | |

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